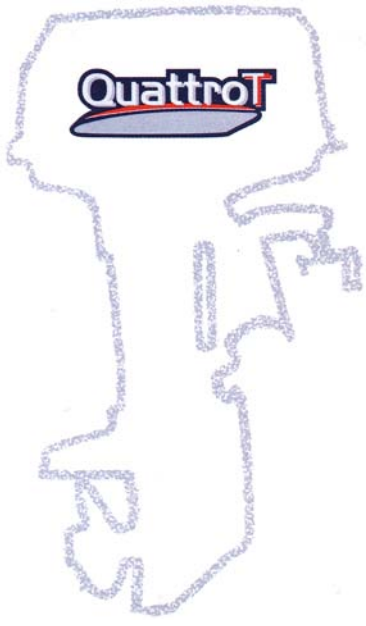
Aruana 40 EFI

SERVICE MANUAL



SELVA
Marine

Preface

This manual has been prepared by Selva primarily for use by Selva dealers and their trained mechanics when performing maintenance procedures and repairs to Selva equipment. It has been written to suit the needs of persons who have basic understanding of the mechanical and electrical concepts and procedures inherent in the work, for without such knowledge attempted repairs or service to the equipment could render it unsafe or unfit for use.
Because Selva has a policy of continuously improving its products, models may differ in detail from the descriptions and illustrations given in this publication. Use only the latest edition of this manual. Authorized Selva dealers are notified periodically of modifications and significant changes in specifications and procedures, and these are incorporated in successive editions of this manual.

Important information

Particularly important information is distinguished in this manual by the following notations:

⚠ The Safety Alert Symbol means ATTENTION! BECOME ALERT! YOUR SAFETY IS INVOLVED!

⚠ WARNING

A WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.

NOTICE

A NOTICE indicates special precautions that must be taken to avoid damages to the outboard motor or other property.

TIP:

A TIP provides key information to make procedures easier or clearer.

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General information

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⚠Safety while working

To prevent an accident or injury and to ensure quality service, follow the safety procedures provided below.

Rotating part

- Hands, feet, hair, jewelry, clothing, Personal flotation device straps, and so on can become entangled with internal rotating parts of the engine, resulting in serious injury or death.
- Keep the top cowling in place whenever possible. Do not remove or replace the cowling with the engine running.
- Only operate the engine with the cowling removed according to the specific instructions in the manual. Keep hands, feet, hair, jewelry, clothing, Personal flotation device straps, and so on away from any exposed moving parts.

Hot part

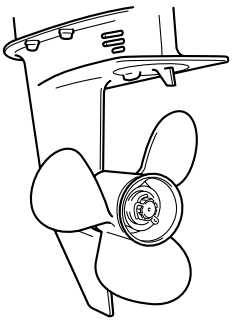
During and after operation, engine parts are hot enough to cause burns. Avoid touching any parts under the top cowling until the engine has cooled.

Electric shock

Do not touch any electrical parts while starting or operating the engine. They can cause shock or electrocution.

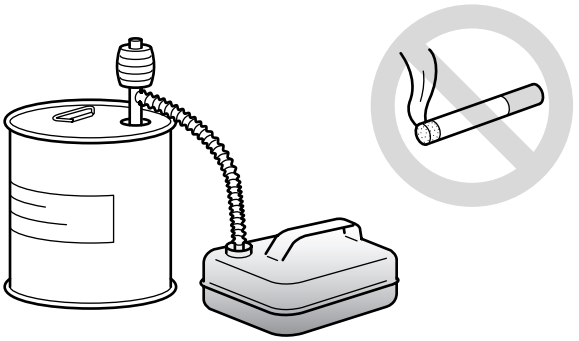
Propeller

Do not hold the propeller with your hands when loosening or tightening it.



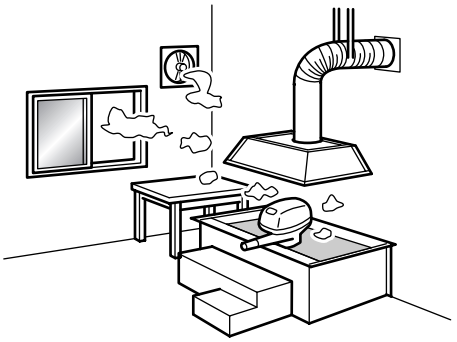
Handling of gasoline

- Gasoline is highly flammable. Keep gasoline and all flammable products away from heat, sparks, and open flames.
- Gasoline is poisonous and can cause injury or death. Handle gasoline with care. Never siphon gasoline by mouth. If you happen to swallow some gasoline or inhale a lot of gasoline vapor, or get some gasoline in your eyes, see your doctor immediately. If gasoline spills on your skin, wash with soap and water. If gasoline spills on your clothing, change your clothes.



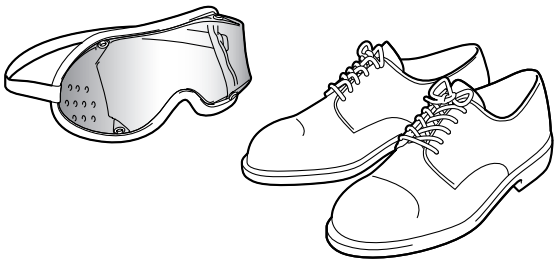
Ventilation

- Gasoline vapor and exhaust gas are heavier than air and extremely poisonous. If inhaled in large quantities they may cause loss of consciousness and death within a short time.
- When test running an engine indoors (example: in a water tank), make sure to do so where adequate ventilation can be maintained.



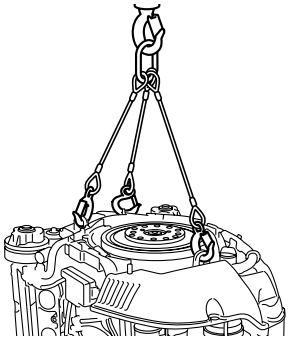
Self-protection

- Protect your eyes by wearing safety glasses or safety goggles during all operations involving drilling and grinding, or when using an air compressor.
- Protect your hands and feet by wearing protective gloves and safety shoes when necessary.



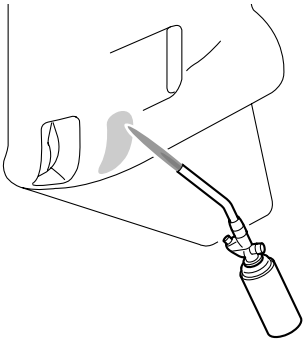
Working with crane

- Outboard motors weighing 18.0 kg (39.7 lb) and over must be carried by a crane.
- Use a wire rope of adequate strength, and lift up the outboard motor with the three point suspension.
- If the outboard motor does not have three or more points to be suspended, support it with additional ropes or the like so that the outboard motor can be lifted and carried in a stable manner.



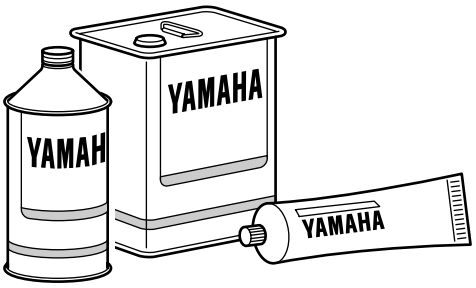
Handling of burner

- Incorrect handling of burner may result in burns. Refer to the operation manual issued by the manufacturer to assure the correct handling.
- When using a burner, keep it away from the gasoline and oil, to prevent a fire.
- Components become hot enough to cause burns. Do not touch them directly.



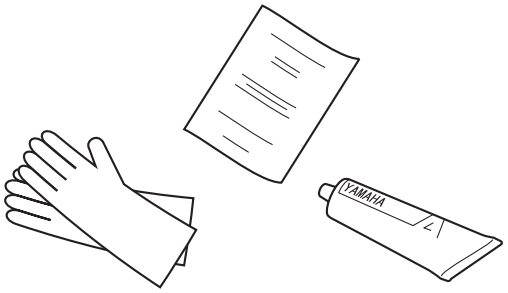
Part, lubricant, and sealant

Use only genuine Selva parts, lubricants, and sealants or those recommended by Selva, when servicing or repairing the outboard motor.



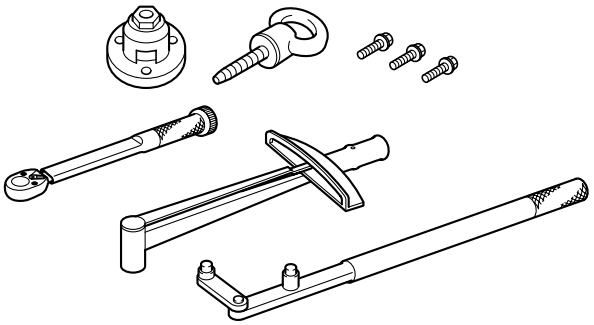
Handling of sealant

- Wear protective gloves to protect your skin, when using the sealants.
- Refer to the material data sheet issued by the manufacturer. Some of the sealants may be harmful for human health.



Special service tool

Use the recommended special service tools to work safety, and to protect parts from damage.

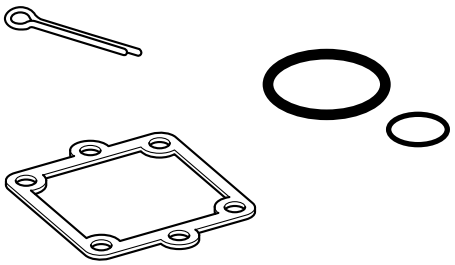


Tightening torque

Follow the tightening torque specifications provided throughout the manual. When tightening nuts, bolts, and screws, tighten the large sizes first, and tighten fasteners starting in the center and moving outward.

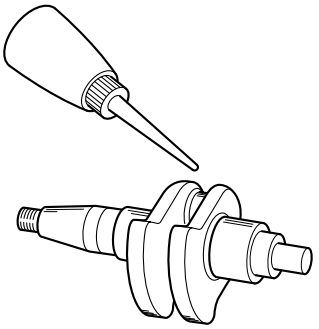
Non-reusable part

Always use new gaskets, seals, O-rings, cotter pins, and so on, when installing or assembling parts.



Disassembly and assembly

- Use compressed air to remove dust and dirt during disassembly.
- Apply engine oil to the contact surfaces of moving parts before assembly.



- Install bearings with the manufacture identification mark in the direction indicated in the installation procedure. In addition, be sure to lubricate the bearings liberally.
- Apply a thin coat of water-resistant grease to the lip and periphery of an oil seal before installation.
- Check that moving parts operate normally after assembly.

How to use this manual

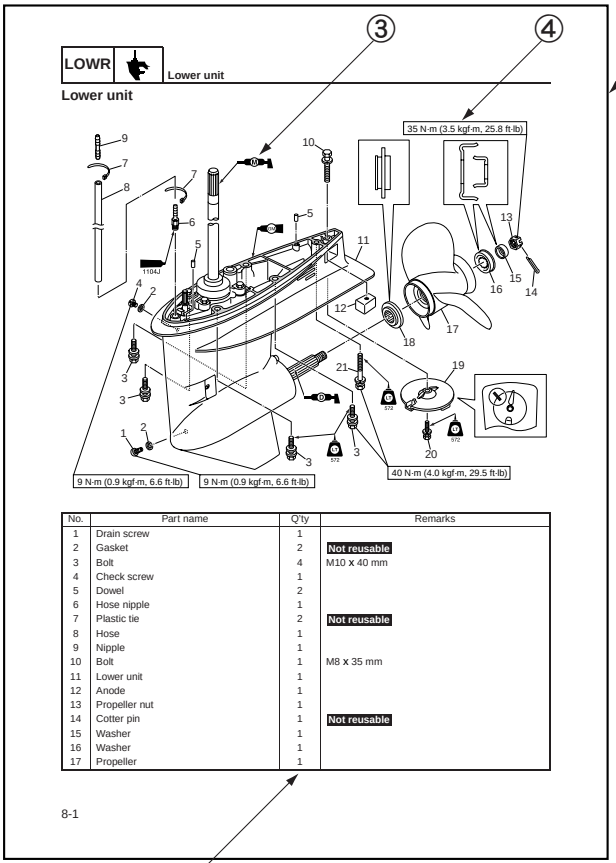
Manual format

The format of this manual has been designed to make service procedures clear and easy to understand. Use the information below as a guide for effective and quality service.

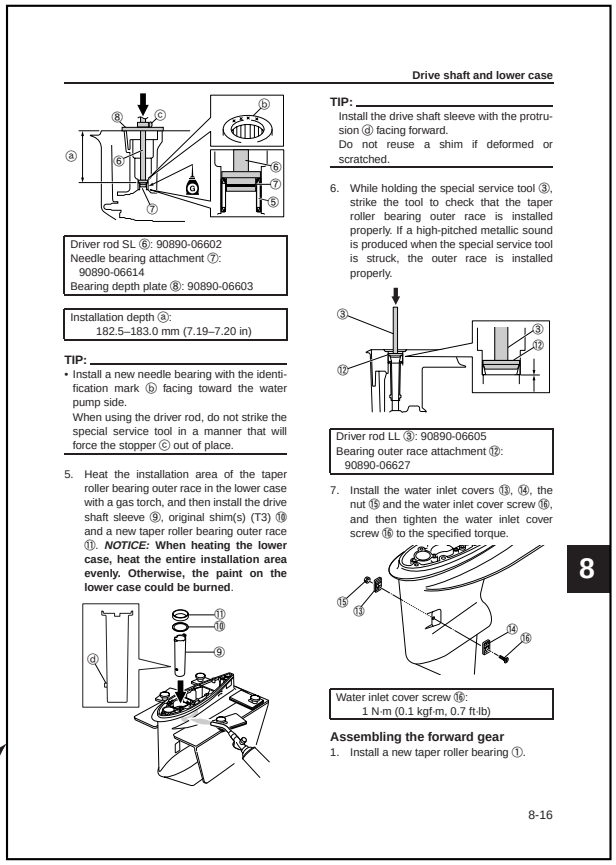
- Parts are shown and detailed in an exploded diagram and are listed in the component list (see ① in the figure below for an example page).
- The component list consists of part names and quantities, as well as bolt and screw dimensions (see ② in the figure below).
- Symbols are used to indicate important aspects of a procedure, such as the grade of lubricant and lubrication point (see ③ in the figure below).
- Tightening torque specifications are provided in the exploded diagrams (see ④ in the figure below for an example), and in the related detailed instructions. Some torque specifications are listed in stages as torque figures or angles in degrees.
- Separate procedures and illustrations are used to explain the details of removal, checking, and installation where necessary (see ⑤ in the figure below for an example page).

TIP:

For troubleshooting procedures, see Chapter 4, “Troubleshooting.”



No.	Part name	Q'ty	Remarks
1	Drain screw	1	
2	Gasket	2	Not reusable
3	Bolt	4	M10 x 40 mm
4	Check screw	1	
5	Dowel	2	
6	Hose nipple	1	
7	Plastic tie	2	Not reusable
8	Hose	1	
9	Nipple	1	
10	Bolt	1	M8 x 35 mm
11	Lower unit	1	
12	Anode	1	
13	Propeller nut	1	
14	Cotter pin	1	Not reusable
15	Washer	1	
16	Washer	1	
17	Propeller	1	


Drive shaft and lower case
Driver rod SL ⑥: 90890-06602
Needle bearing attachment ⑦:
90890-06614
Bearing depth plate ⑧: 90890-06603
Installation depth ⓐ:
182.5–183.0 mm (7.19–7.20 in)
TIP:
• Install a new needle bearing with the identification mark ⓑ facing toward the water pump side.
When using the driver rod, do not strike the special service tool in a manner that will force the stopper ⓒ out of place.
5. Heat the installation area of the taper roller bearing outer race in the lower case with a gas torch, and then install the drive shaft sleeve ⑨, original shim(s) (T3) ⑩ and a new taper roller bearing outer race ⑪. NOTICE: When heating the lower case, heat the entire installation area evenly. Otherwise, the paint on the lower case could be burned.
TIP:
Install the drive shaft sleeve with the protrusion ⓓ facing forward.
Do not reuse a shim if deformed or scratched.
6. While holding the special service tool ③, strike the tool to check that the taper roller bearing outer race is installed properly. If a high-pitched metallic sound is produced when the special service tool is struck, the outer race is installed properly.
Driver rod LL ③: 90890-06605
Bearing outer race attachment ⑫:
90890-06627
7. Install the water inlet covers ⑬, ⑭, the nut ⑮ and the water inlet cover screw ⑯, and then tighten the water inlet cover screw ⑯ to the specified torque.
Water inlet cover screw ⑯:
1 N·m (0.1 kgf-m, 0.7 ft-lb)
Assembling the forward gear
1. Install a new taper roller bearing ①.
8-16
⑤

Abbreviation

The following abbreviations are used in this service manual.

Abbreviation	Description
API	American Petroleum Institute
ATDC	After Top Dead Center
BTDC	Before Top Dead Center
CCA	Cold Cranking Ampere
C/E	Check Engine
ECM	Electronic Control Module
EN	European Norm (European standard)
EX	Exhaust
F	Forward
IC	Integrated Circuit
ID	Identification
IEC	International Electro-technical Commission
IN	Intake
ISC	Idle Speed Control
N	Neutral
PORT	Port side
PTT	Power Trim and Tilt
R	Reverse
RON	Research Octane Number
SAE	Society of Automotive Engineers
SOHC	Single Overhead Camshaft
STBD	Starboard side
TDC	Top Dead Center
TPS	Throttle Position Sensor
W/F	Water in Fuel

Sealant and locking agent

Symbol

Symbols in an exploded diagram or illustration indicate the grade of lubricant and the lubrication points.

Symbol	Name	Application
	Selva 4-stroke motor oil	Lubricant
	Gear oil	Lubricant
	Water resistant grease	Lubricant
	Molybdenum disulfide grease	Lubricant
	Corrosion resistant grease	Lubricant
	Low temperature resistant grease	Lubricant

Symbols in an exploded diagram or illustration indicate the type of sealant or thread locking agent and the application points.

Symbol	Name	Application
	Gasket Maker	Sealant
	ThreeBond 1104J	Sealant
	ThreeBond 1322	Sealant
	ThreeBond 1377B	Thread locking agent
	ThreeBond 1401	Thread locking agent
	LOCTITE 271 (red)	Thread locking agent
	LOCTITE 242 (blue)	Thread locking agent

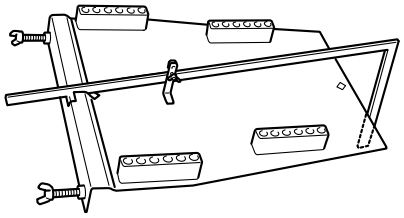
Symbol	Name	Application
LT 572	LOCTITE 572 (white)	Sealant
SS	Silicone sealant	Sealant

Special service tool

For all markets except U.S.A. and Canada

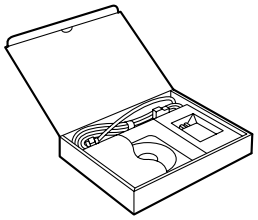
Special tools with Selva parts number (90890-*****) are distributed by the Parts Division.

Drilling plate
90890-06783

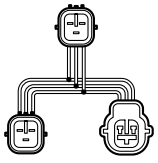


YDIS (CD-ROM, Ver. 1.32)
60V-WS853-05

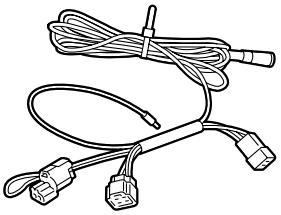
YDIS (KIT)
60V-85300-05



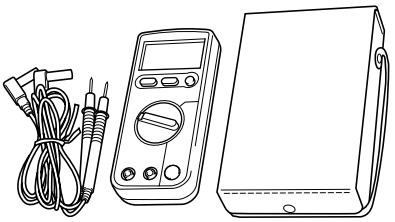
YDIS connecting harness
90890-06882



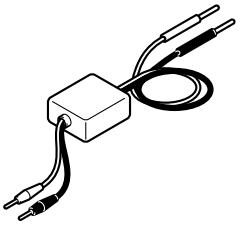
Diagnostic flash indicator B
90890-06865



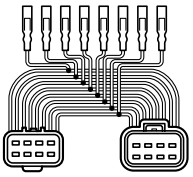
Digital circuit tester
90890-03174



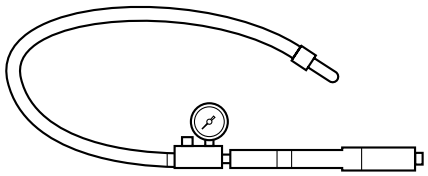
Peak voltage adapter B
90890-03172



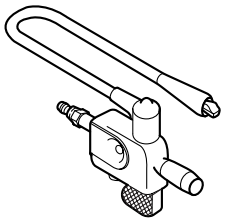
Test harness (8 pins)
90890-06879



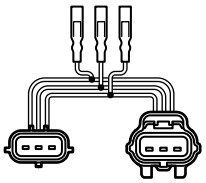
Leakage tester
90890-06840



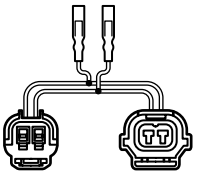
Ignition tester (Spark gap tester)
90890-06754



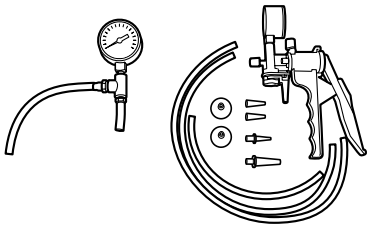
Test harness (3 pins)
90890-06869



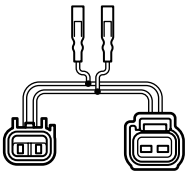
Test harness (2 pins)
90890-06861



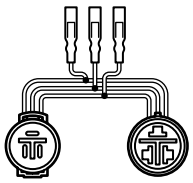
Vacuum/pressure pump gauge set
90890-06756



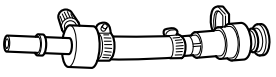
Test harness (2 pins)
90890-06867



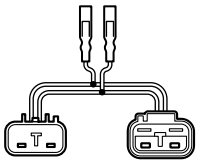
Test harness (3 pins)
90890-06870



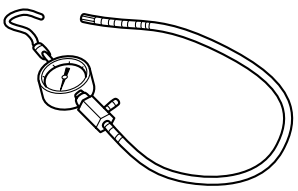
Fuel pressure gauge adapter
90890-06842



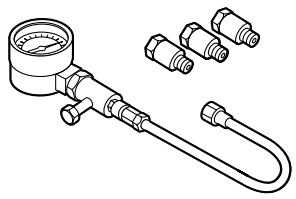
Test harness (2 pins)
90890-06887



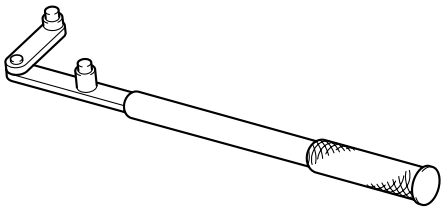
Fuel pressure gauge
90890-06786



Compression gauge
90890-03160



Flywheel holder
90890-06522



Flywheel puller
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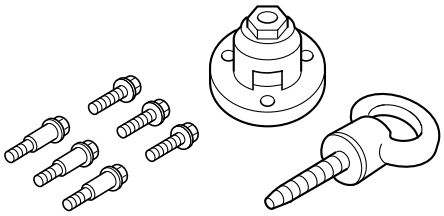
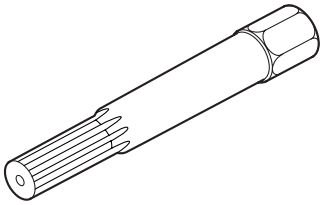
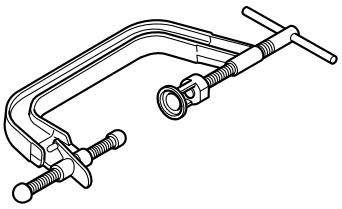


Crankshaft holder 16
90890-06355



Valve spring compressor
90890-04019



Valve spring compressor attachment
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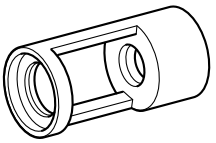

Valve guide remover/installer 5.4
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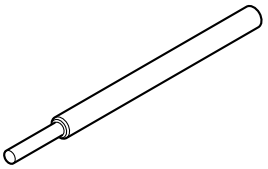

Valve guide reamer 5.5
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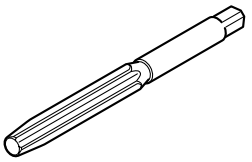

Valve lapper
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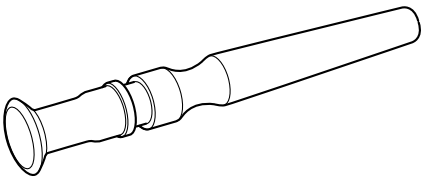

Valve seat cutter holder ø5.5
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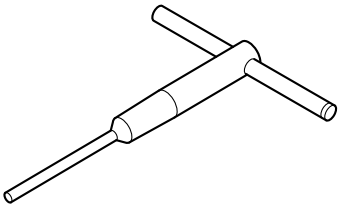
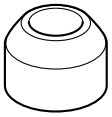
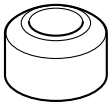


Valve seat cutter 30°
90890-06326

Valve seat cutter 60°
90890-06315



Valve seat cutter 45°
90890-06312



Driver rod LS
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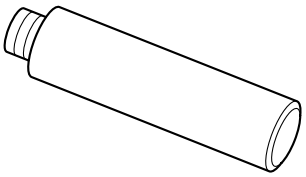

Valve seat cutter 60°
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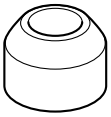

Bearing outer race attachment
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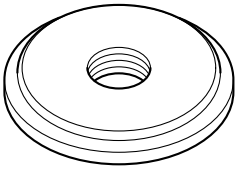

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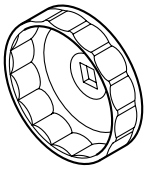
Oil filter wrench 64
90890-01426



Valve seat cutter 45°
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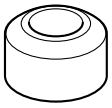

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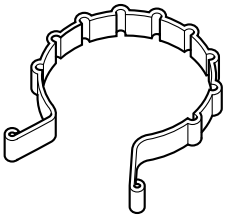

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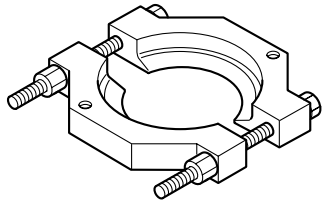

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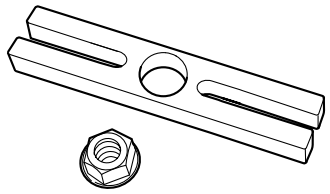
90890-06501



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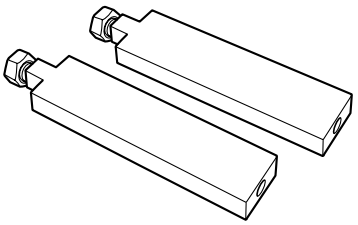

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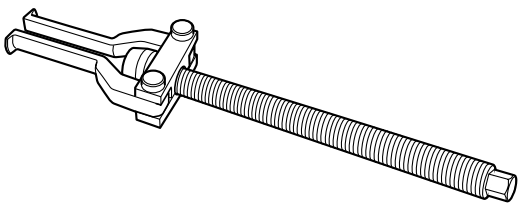

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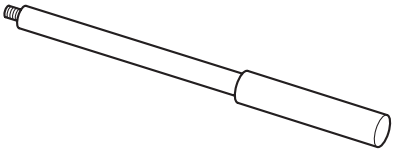
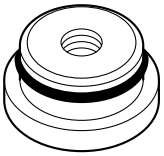


Needle bearing attachment
90890-06614



Needle bearing attachment
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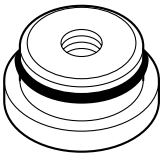

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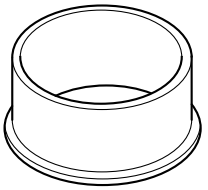

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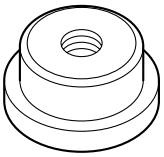

Drive shaft holder 3
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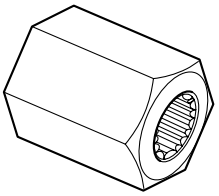

Pinion nut holder
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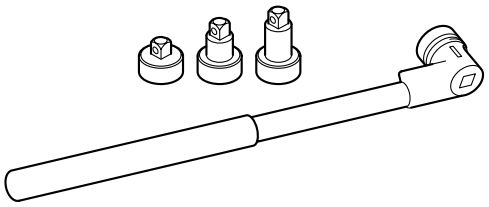

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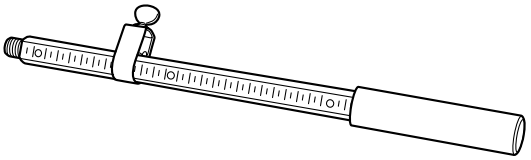

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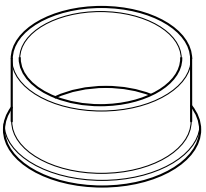

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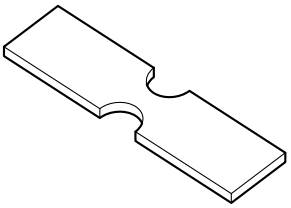

Needle bearing attachment
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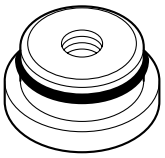

Bearing outer race attachment
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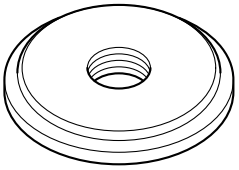

Driver rod LL
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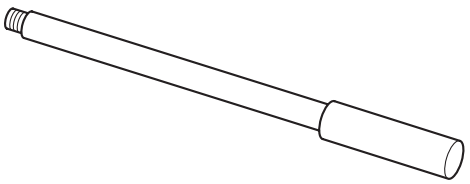

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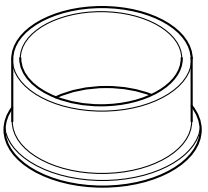

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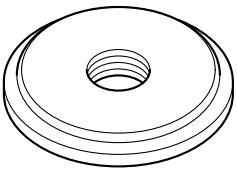

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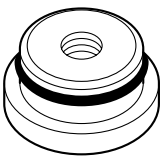

Shift rod push arm
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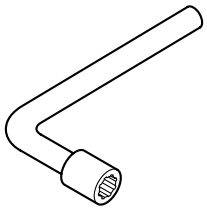

Dial gauge set
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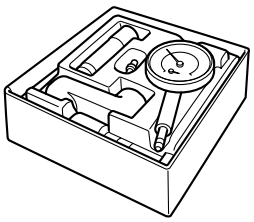
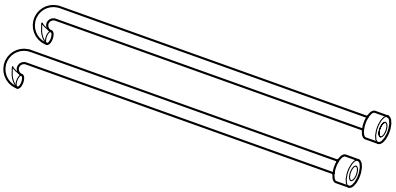
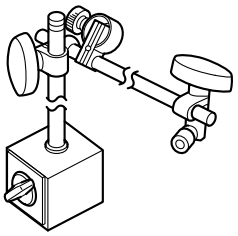


Bearing housing puller claw S
90890-06564



Magnet base B
90890-06844



Center bolt
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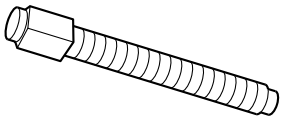

Pinion height gauge
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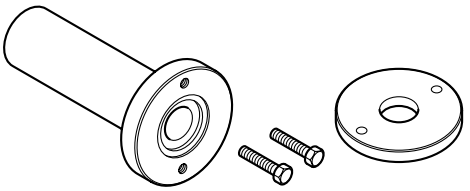

Backlash indicator
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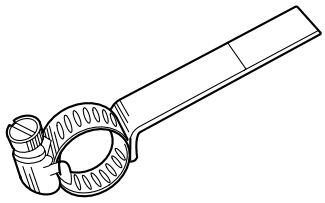

Bushing installer center bolt
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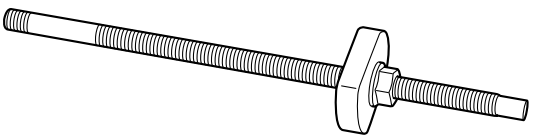

Magnet base plate
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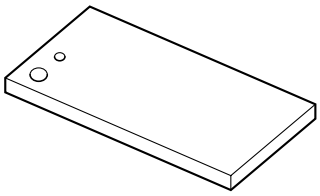
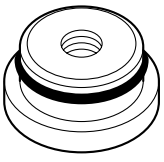


Needle bearing attachment
90890-06613



Needle bearing attachment
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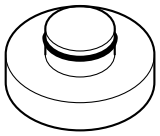
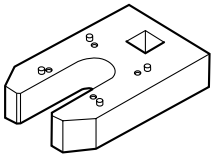


Cylinder-end screw wrench
90890-06568



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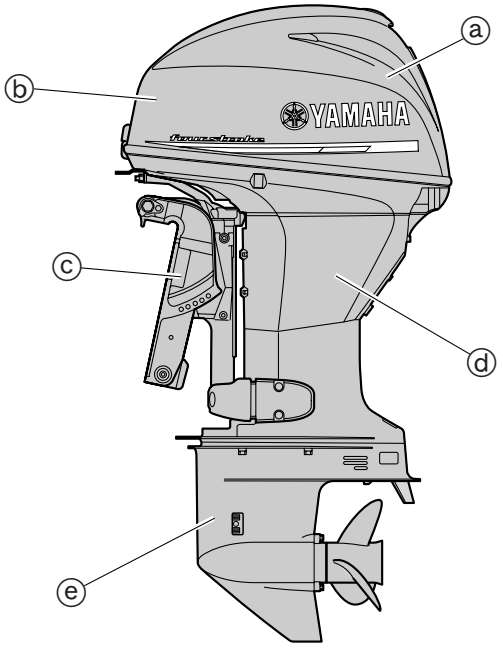
Model features

General feature

Overall features

- Electronic fuel injected, 4-stroke, L3, SOHC, 6-valve, 747.0 cm^3 (45.6 cu. in) engine
- Low emission in compliance with EU regulations

- 6Y8 Multifunction Meter (option)



ⓐ **Power unit**
- Multipoint electronic fuel injection
- Single throttle body
- Long intake manifold
- Blowby gas reburning system
- Fuel cooler
- Closed fuel vapor gas system
- One piece top cowling with water draining air intake duct
- Speed sensor and water pressure sensor (option)

ⓑ **Electrical**
- Variable trolling speed control (tiller handle model or 6Y8 Multifunction Meter equipped model)
- Alert systems including low oil pressure, overheat, and water detection
- New YDIS 1.32 version
- Start-in-gear protection

ⓒ **Bracket unit**
- Long span mounts
- Small and compact PTT (PTT model)
- High-pressure gas-assisted hydro tilt (hydro tilt model)
- Multifunction tiller handle

ⓓ **Upper case**
- Labyrinth idle exhaust system

ⓔ **Lower unit**
- Lower unit equivalent to that of a one-class-higher model

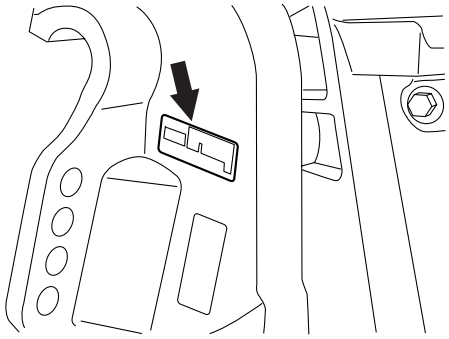
Model designation

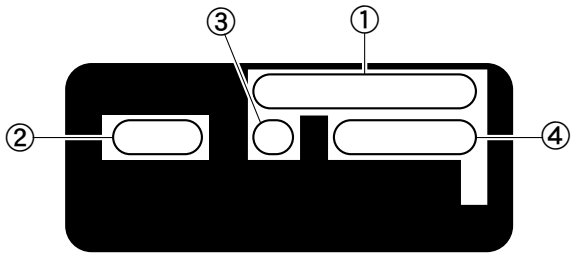
F 40 F E H D L
① ② ③ ④ ⑤ ⑥ ⑦

①	Model description	F: 4-stroke regular rotation
②	Model name	40: 40
③	Product generation	F: A and up
④	Functions	E: Electric starter
⑤		H: Tiller handle
⑥		D: Hydro tilt
		T: PTT
⑦	Transom height	S: S (15 in)
		L: L (20 in)

Serial number

The outboard motor serial number is stamped on a label attached to the port clamp bracket.





① Model name
② Approved model code
③ Transom height
④ Serial number

Model data

Dimension and Weight

Item	Unit	Model			
		EBS			E.ST.PT
Overall length	mm (in)	1362.0 (53.6)		717.0 (28.2)	
Overall width	mm (in)	384.0 (15.1)			
Overall height					
(S)	mm (in)	1228.0 (48.3)	—	1228.0 (48.3)	
(L)	mm (in)	1350.0 (53.1)			
Boat transom height					
(S)	mm (in)	414.0 (16.3)	—	414.0 (16.3)	
(L)	mm (in)	536.0 (21.1)			
Weight (without propeller)					
(S)	kg (lb)	97.1 (214.1)	—	92.1 (203.4)	93.6 (206.4)
(L)	kg (lb)	102.7 (226.4)	104.6 (230.6)	97.7 (215.4)	99.6 (219.6)

Performance

Item	Unit	Model			
		EBS			E.ST.PT
Maximum output	kW (HP)	29.2 (40) at 5500 r/min			
Full throttle operating range	r/min	5000–6000			
Maximum fuel consumption	L (US gal, Imp gal)/hr	13.6 (3.6, 3.0) at 5500 r/min			
Engine idle speed	r/min	750–850			

Power unit

Item	Unit	Model			
		EBS			E.ST.PT
Type		4-stroke, SOHC L			
Cylinder quantity		3			
Total displacement	cm^3 (cu. in)	747.0 (45.6)			
Bore × stroke	mm (in)	65.0 × 75.0 (2.56 × 2.95)			
Compression ratio		9.40 : 1			
Control system		Tiller handle		Remote control	
Starting system		Electric			
Fuel system		Fuel injection			
Ignition control system		CDI (built-in to the engine ECM)			
Advance type		Microcomputer			
Maximum generator output	V, A	12.0, 17.0			
Spark plug		DPR6EB-9 (NGK)			
Firing order		1–2–3			
Cooling system		Water			

Item	Unit	Model			
		EBS			E.ST.PT
Exhaust system		Propeller boss			
Lubrication system		Wet sump			

Lower unit

Item	Unit	Model			
		EBS			E.ST.PT
Gear shift positions		F-N-R			
Gear ratio		2.00 (26/13)			
Reduction gear type		Spiral bevel gear			
Clutch type		Dog clutch			
Propeller shaft type		Spline			
Propeller direction (rear view)		Clockwise			
Propeller mark		G			

Bracket unit

Item	Unit	Model			
		EBS			E.ST.PT
Trim angle (at 12º boat transom)	Degree	–3 to 16			
Tilt-up angle	Degree	65	66	65	66
Steering angle	Degree	40 + 40			
Trim and tilt system		Hydro	PTT	Hydro	PTT

Fuel and oil requirement

Item	Unit	Model			
		EBS			E.ST.PT
Fuel type		Regular unleaded gasoline			
Fuel minimum rating	RON	91			
Engine oil		4-stroke motor oil with combinations of the following SAE and API oil classifications			
Engine oil grade (*1)	API	SE, SF, SG, SH, SJ, or SL			
	SAE	5W-30, 10W-30, or 10W-40			
Total engine oil quantity					
without oil filter replacement	L (US qt, Imp qt)	1.5 (1.59, 1.32)			
with oil filter replacement	L (US qt, Imp qt)	1.7 (1.80, 1.50)			
Gear oil type		Hypoid gear oil			
Gear oil grade(*2)	API	GL-4			
	SAE	90			
Gear oil quantity	L (US qt, Imp qt)	0.430 (0.455, 0.378)			

(*1) If the recommended engine oil grades are not available, use engine oil with an API classification of SH, SJ, or SL and an SAE classification of 15W-40, 20W-40, or 20W-50.
(*2) Meeting both API and SAE requirements.

Battery requirement

Item	Unit	Model			
		EBS			E.ST.PT
Minimum cold cranking amps CCA/EN	A	430.0			
Minimum rated capacity 20HR/IEC	Ah	70.0			

PTT requirement

Item	Unit	Model			
		EBS			E.ST.PT
Fluid type		—	ATF Dexron II	—	ATF Dexron II

Electrical technical data

Ignition timing control system

Item	Unit	Model			
		EBS			E.ST.PT
Engine ECM					
Output peak voltage					
at cranking (unloaded)	V	100.0			
Spark plug cap					
Resistance (*1)					
at 20 °C (68 °F)	kΩ	5.0			
Ignition coil					
Primary coil resistance (*1)					
at 20 °C (68 °F)	Ω	0.1789–0.2415			
Secondary coil resistance					
at 20 °C (68 °F)	kΩ	3.256–4.884			
Pulser coil					
Output peak voltage					
at cranking (unloaded)	V	5.0			
at cranking (loaded)	V	2.7			
at 1500 r/min (loaded)	V	6.5			
at 3500 r/min (loaded)	V	9.8			
Resistance					
at 20 °C (68 °F)	Ω	152.0–228.0			
Thermo sensor					
Input voltage	V	4.75–5.25			
Resistance (*1)					
at 20 °C (68 °F)	kΩ	26.460			
at 75 °C (167 °F)	kΩ	0.370			
at 90 °C (194 °F)	Ω	240.3			
Neutral switch					
Input voltage (*1)	V	11.1			

Item	Unit	Model			
		EBS			E.ST.PT
Spark plug Gap	mm (in)	0.8–0.9 (0.032–0.035)			

(*1) The figures are for reference only.

Fuel injection control system

Item	Unit	Model			
		EBS			E.ST.PT
Water detection switch					
Input voltage	V	4.75–5.25			
Float height (*1)	mm (in)	19.4 (0.74)			
Fuel injector					
Input voltage	V	12.0			
Resistance (*1)					
at 20 °C (68 °F)	Ω	12.0			
High-pressure fuel pump					
Input voltage	V	12.0			
Resistance (*1)					
at 20 °C (68 °F)	Ω	1.4–1.7			
Vapor shut-off valve					
Input voltage	V	12.0			
Resistance					
at 20 °C (68 °F)	Ω	30.0–34.0			

(*1) The figures are for reference only.

Engine speed control system

Item	Unit	Model			
		EBS			E.ST.PT
Throttle body					
Input voltage	V	4.75–5.25			
TPS					
Output voltage (*1)					
with throttle valve fully closed	V	0.674			
with throttle valve fully open	V	3.680			
Throttle valve opening angle (*1)					
with throttle valve fully closed	Degree	0.1			
with throttle valve fully open	Degree	75.3			

Item	Unit	Model			
		EBS			E.ST.PT
Oil pressure switch					
Input voltage	V	12.0			
Working pressure	kPa (kgf/cm^2, psi)	29.4–58.8 (0.294–0.588, 4.3–8.5)			

(*1) The figures are for reference only.

PTT system

Item	Unit	Model			
		EBS			E.ST.PT
Trim sensor					
Free position resistance (*1)	Ω	—			238.8–378.8
Setting resistance	Ω	—			9.0–11.0

(*1) The figures are for reference only.

Charging system

Item	Unit	Model			
		EBS			E.ST.PT
Lighting coil					
Output peak voltage					
at cranking (unloaded)	V	14.0			
at 1500 r/min (unloaded)	V	45.0			
at 3500 r/min (unloaded)	V	102.0			
Resistance (*1)					
at 20 °C (68 °F)	Ω	0.561–0.759			
Fuse	A	30			
Rectifier Regulator					
Output peak voltage					
at 1500 r/min (unloaded)	V	13.0			
at 3500 r/min (unloaded)	V	13.0			

(*1) The figures are for reference only.

Starting system

Item	Unit	Model			
		EBS			E.ST.PT
Starter motor					
Type		Sliding gear			
Output	kW	0.90			
Cranking time limit	Second	30			
Commutator					
Standard diameter	mm (in)	29.4 (1.16)			
Wear limit	mm (in)	28.8 (1.13)			
Standard undercut	mm (in)	0.5 (0.02)			
Wear limit	mm (in)	0.2 (0.01)			
Brushes					
Standard length	mm (in)	12.3 (0.48)			
Wear limit	mm (in)	5.5 (0.22)			

Gauge / sensor

Item	Unit	Model			
		EBS			E.ST.PT
Water pressure sensor					
Input voltage	V	4.75–5.25			
Output voltage (*1)					
at 392.0 kPa (3.92 kgf/cm^2, 56.8 psi)	V	2.5			
at 784.0 kPa (7.84 kgf/cm^2, 113.7 psi)	V	4.5			
Speed sensor					
Input voltage	V	4.75–5.25			
Output voltage (*1)					
at 392.0 kPa (3.92 kgf/cm^2, 56.8 psi)	V	2.5			
at 784.0 kPa (7.84 kgf/cm^2, 113.7 psi)	V	4.5			

(*1) The figures are for reference only.

Fuel system technical data

Fuel system

Item	Unit	Model			
		EBS			E.ST.PT
Fuel pressure (*1)					
Within 3 seconds after engine start switch turned to "ON"	kPa (kgf/cm^2, psi)	280.0 (2.80, 40.6)			
at engine idle speed	kPa (kgf/cm^2, psi)	230.0 (2.30, 33.4)			
Fuel joint					
Holding pressure					
Positive pressure	kPa (kgf/cm^2, psi)	50.0 (0.50, 7.3)			
Fuel filter assembly					
Holding pressure					
Positive pressure	kPa (kgf/cm^2, psi)	200.0 (2.00, 29.0)			
Negative pressure	kPa (kgf/cm^2, psi)	80.0 (0.80, 11.6)			
Fuel pump					
Holding pressure					
Inlet positive pressure	kPa (kgf/cm^2, psi)	50.0 (0.50, 7.3)			
Inlet negative pressure	kPa (kgf/cm^2, psi)	30.0 (0.30, 4.4)			
Outlet positive pressure	kPa (kgf/cm^2, psi)	50.0 (0.50, 7.3)			
Primer pump					
Holding pressure					
Positive pressure	kPa (kgf/cm^2, psi)	170.0 (1.70, 24.7)			
Vapor separator tank					
Float height (open)	mm (in)	42.1 $\pm$ 2.0 (1.66 $\pm$ 0.08)			
Float height (closed) (*1)	mm (in)	30.7 (1.21)			
Fuel strainer					
Holding pressure	kPa (kgf/cm^2, psi)	200.0 (2.00, 29.0)			

(*1) The figures are for reference only.

Power unit technical data

Power unit

Item	Unit	Model			
		EBS			E.ST.PT
Cylinder					
Minimum compression pressure (*1)	kPa (kgf/cm^2, psi)	840.0 (8.40, 121.8)			
Engine oil					
Oil pressure (*2)					
at 60 °C (140 °F) with SL 10W-30 engine oil and at 800 r/min	kPa (kgf/cm^2, psi)	230.0 (2.30, 33.4)			
at 61 °C (142 °F) with SL 10W-30 engine oil and at 3000 r/min	kPa (kgf/cm^2, psi)	480.0 (4.80, 69.6)			
Thermostat					
Valve opening temperature	°C (°F)	58–62 (136–144)			
Fully open temperature	°C (°F)	70 (158)			
Fully open stroke	mm (in)	3.0 (0.12)			

(*1) Measuring conditions: Ambient temperature 20 °C (68 °F), fully open throttle, and the spark plugs removed from all cylinders. The figures are for reference only.

(*2) For details of the checking method, see “Checking the oil pressure” (7-1). The figures are for reference only.

Cylinder head assembly

Item	Unit	Model			
		EBS			E.ST.PT
Valve					
Clearance					
Intake	mm (in)	0.20 ± 0.05 (0.008 ± 0.002)			
Exhaust	mm (in)	0.30 ± 0.05 (0.012 ± 0.002)			
Seat contact width	mm (in)	1.30–1.50 (0.051–0.059)			
Margin thickness					
Intake	mm (in)	0.80–1.20 (0.0315–0.0472)			
Exhaust	mm (in)	1.00–1.40 (0.0394–0.0551)			
Cylinder head					
Warpage limit	mm (in)	0.10 (0.0039)			
Valve spring					
Free length	mm (in)	39.85 (1.57)			
Tilt	mm (in)	1.7 (0.07)			
Valve stem					
Diameter					
Intake	mm (in)	5.475–5.490 (0.2156–0.2161)			
Exhaust	mm (in)	5.460–5.475 (0.2150–0.2156)			
Runout	mm (in)	0.01 (0.0004)			

Item	Unit	Model			
		EBS			E.ST.PT
Valve guide					
Inside diameter	mm (in)	5.500–5.512 (0.2165–0.2170)			
Stem-to-guide clearance					
Intake	mm (in)	0.010–0.037 (0.0004–0.0015)			
Exhaust	mm (in)	0.025–0.052 (0.0010–0.0020)			
Position	mm (in)	16.3–16.7 (0.64–0.66)			
Rocker arm					
Inside diameter	mm (in)	16.000–16.018 (0.6299–0.6306)			
Rocker arm shaft					
Outside diameter	mm (in)	15.971–15.991 (0.6288–0.6296)			
Cam shaft					
Cam lobe height					
Intake	mm (in)	30.737–30.837 (1.2101–1.2141)			
Exhaust	mm (in)	30.933–31.033 (1.2178–1.2218)			
Cam lobe width	mm (in)	25.950–26.050 (1.0217–1.0256)			
Runout	mm (in)	0.007 (0.0003)			
Journal diameter #1	mm (in)	36.925–36.945 (1.4537–1.4545)			
Journal diameter #2, #3	mm (in)	36.935–36.955 (1.4541–1.4549)			
Cylinder head journal inside diameter	mm (in)	37.000–37.025 (1.4567–1.4577)			

Crankcase assembly

Item	Unit	Model			
		EBS			E.ST.PT
Piston					
Diameter	mm (in)	64.950–64.965 (2.5571–2.5577)			
Measuring point	mm (in)	5.0 (0.20)			
Oversize diameter					
1st	mm (in)	65.200–65.215 (2.5669–2.5675)			
2nd	mm (in)	65.450–65.465 (2.5768–2.5774)			
Piston clearance	mm (in)	0.035–0.065 (0.0014–0.0026)			
Ring groove (Top)	mm (in)	1.21–1.23 (0.0476–0.0484)			
Ring groove (2nd)	mm (in)	1.51–1.53 (0.0594–0.0602)			
Ring groove (Oil)	mm (in)	2.52–2.54 (0.0992–0.1000)			
Pin boss inside diameter	mm (in)	15.974–15.985 (0.6289–0.6293)			
Pin outside diameter	mm (in)	15.965–15.970 (0.6285–0.6287)			
Cylinder					
Bore	mm (in)	65.000–65.015 (2.5591–2.5596)			

Item	Unit	Model			
		EBS			E.ST.PT
Piston ring					
End gap measuring point	mm (in)	10.0 (0.39)			
Top ring					
Type		Barrel			
Dimension height (B)	mm (in)	1.17–1.19 (0.0461–0.0469)			
Dimension width (T)	mm (in)	2.30–2.50 (0.0906–0.0984)			
End gap (*1)	mm (in)	0.15–0.30 (0.0059–0.0118)			
Side clearance	mm (in)	0.02–0.06 (0.0008–0.0024)			
2nd ring					
Type		Taper			
Dimension height (B)	mm (in)	1.47–1.49 (0.0579–0.0587)			
Dimension width (T)	mm (in)	2.60–2.80 (0.1024–0.1102)			
End gap (*1)	mm (in)	0.30–0.50 (0.0118–0.0197)			
Side clearance	mm (in)	0.02–0.06 (0.0008–0.0024)			
Oil ring					
Dimension height (B)	mm (in)	2.36–2.48 (0.0929–0.0976)			
Dimension width (T)	mm (in)	2.75 (0.1083)			
End gap (*1)	mm (in)	0.20–0.70 (0.0079–0.0276)			
Side clearance	mm (in)	0.04–0.18 (0.0016–0.0071)			
Connecting rod					
Small end inside diameter	mm (in)	15.985–15.998 (0.6293–0.6298)			
Big end inside diameter	mm (in)	36.000–36.024 (1.4173–1.4183)			
Big end side clearance	mm (in)	0.05–0.22 (0.0020–0.0087)			
Crankpin oil clearance	mm (in)	0.016–0.040 (0.0006–0.0016)			
Crankshaft					
Journal diameter	mm (in)	42.984–43.000 (1.6923–1.6929)			
Crankpin diameter	mm (in)	32.984–33.000 (1.2986–1.2992)			
Crankpin width	mm (in)	21.00–21.07 (0.8268–0.8295)			
Runout	mm (in)	0.03 (0.0012)			
Crankcase					
Crankshaft journal oil clearance	mm (in)	0.012–0.036 (0.0005–0.0014)			

(*1) The figures are for reference only.

Lower unit technical data

Lower unit assembly

Item	Unit	Model			
		EBS			E.ST.PT
Lower unit					
Holding pressure	kPa (kgf/cm^2, psi)	68.6 (0.686, 9.9)			

Item	Unit	Model			
		EBS			E.ST.PT
Pinion-to-forward gear Backlash (*1)	mm (in)	0.18–0.66 (0.0071–0.0260)			
Pinion-to-reverse gear Backlash (*1)	mm (in)	0.75–1.23 (0.0295–0.0484)			
Pinion shim (T3)	mm	0.10, 0.12, 0.15, 0.18, 0.30, 0.40, 0.50			
Forward gear shim (T1)	mm	0.10, 0.12, 0.15, 0.18, 0.30, 0.40, 0.50			
Reverse gear shim (T2)	mm	0.10, 0.12, 0.15, 0.18, 0.30, 0.40, 0.50			
Propeller shaft Runout	mm (in)	0.02 (0.0008)			
Drive shaft Runout	mm (in)	0.5 (0.0197)			

(*1) Figures obtained using the special service tools.

Bracket unit technical data

PTT system

Item	Unit	Model			
		EBS			E.ST.PT
Motor commutator					
Standard diameter	mm (in)	16.3 (0.64)			
Wear limit	mm (in)	14.9 (0.59)			
Motor brush					
Standard length	mm (in)	7.5 (0.30)			
Wear limit	mm (in)	5.1 (0.20)			

Special tightening torque

Electrical system

Part to be tightened	Screw size	Tightening torques		
		N·m	kgf·m	ft·lb
Starter motor lead screw	M5	3	0.3	2.2

Fuel system

Part to be tightened	Screw size	Tightening torques		
		N·m	kgf·m	ft·lb
Fuel cup assembly	—	5	0.5	3.7
Fuel pump screw	M5	3	0.3	2.2
Link rod locknut	—	5	0.5	3.7
Vapor separator drain screw	—	1.5	0.15	1.11
Float chamber plate screw	M5	2	0.2	1.5
Float chamber cover screw	M5	3	0.3	2.2
Pressure regulator bolt	M6	5	0.5	3.7
Nipple	—	4	0.4	3.0
Fuel cooler screw	M6	3.5	0.35	2.58

Power unit

Part to be tightened		Screw size	Tightening torques		
			N·m	kgf·m	ft·lb
Valve adjusting locknut		—	13.5	1.35	9.96
Spark plug		—	18	1.8	13.3
Power unit mounting bolt	1st	M8	21	2.1	15.5
	2nd		21	2.1	15.5
Apron screw		M6	3	0.3	2.2
PTT motor lead bolt		M6	4	0.4	3.0
Driven sprocket bolt		M10	38	3.8	28.0
Drive sprocket nut		—	150	15.0	110.6
Flywheel magnet nut		—	157	15.7	115.8
YDIS coupler screw		ø6	3	0.3	2.2
Terminal bolt		M6	4	0.4	3.0
Main relay screw		ø6	3	0.3	2.2
Starter relay screw		ø6	3	0.3	2.2
Starter relay lead bolt		M6	4	0.4	3.0
PTT relay lead nut		—	4	0.4	3.0
Shift cable locknut		—	5	0.5	3.7
Throttle cable locknut		—	5	0.5	3.7
Starter motor lead nut		—	9	0.9	6.6
Starter motor lead bolt		M6	4	0.4	3.0
Starter motor bolt		M8	30	3.0	22.1
Cylinder head bolt	1st	M9	12	1.2	8.9
	2nd		23	2.3	17.0
	3rd		90°		
	1st	M6	6	0.6	4.4
	2nd		12	1.2	8.9
Rocker arm shaft bolt		M8	18	1.8	13.3
Cylinder head anode screw		M5	2	0.2	1.5
Cylinder head anode plug		—	18	1.8	13.3
Oil filter union bolt		—	40	4.0	29.5
Oil filter		—	18	1.8	13.3
Oil pressure switch		—	9	0.9	6.6
Oil pressure switch bolt		M4	2	0.2	1.5
Thermo sensor		—	23	2.3	17.0
Exhaust cover bolt	1st	M6	6	0.6	4.4
	2nd		12	1.2	8.9
Exhaust cover anode screw		M5	2	0.2	1.5
Exhaust cover anode plug		—	18	1.8	13.3
Exhaust cover plug		M14	23	2.3	17.0
		M18	56	5.6	41.3
Connecting rod bolt	1st	M6	6	0.6	4.4
	2nd		17	1.7	12.5

Part to be tightened		Screw size	Tightening torques		
			N·m	kgf·m	ft·lb
Crankcase bolt	1st	M8	15	1.5	11.1
	2nd		30	3.0	22.1
	1st	M6	6	0.6	4.4
	2nd		12	1.2	8.9

Lower unit

Part to be tightened	Screw size	Tightening torques		
		N·m	kgf·m	ft·lb
Water inlet cover screw	M5	1	0.1	0.7
Pinion nut	—	74	7.4	54.6
Propeller shaft housing bolt	M8	16	1.6	11.8
Lower case mounting bolt	M8	40	4.0	29.5
	M10	40	4.0	29.5
Propeller nut	—	35	3.5	25.8
Check screw	—	9	0.9	6.6
Drain screw	—	9	0.9	6.6

Tiller handle model

Part to be tightened	Screw size	Tightening torques		
		N·m	kgf·m	ft·lb
Tiller handle nut	—	37	3.7	27.3
Friction plate nut	—	7	0.7	5.2
Friction plate bolt	M6	8	0.8	5.9
Friction adjusting nut	—	4	0.4	3.0
Throttle grip screw	M5	2	0.2	1.5
PTT switch screw	M6	2	0.2	1.5
Grease nipple	—	3	0.3	2.2
Tiller handle bracket bolt	M12	32	3.2	23.6
Tiller handle bracket nut	—	32	3.2	23.6
Engine start switch nut	—	5	0.5	3.7
Engine shut-off switch nut	—	2.5	0.25	1.84
Alert indicator screw	ø6	2	0.2	1.5

Bracket unit

Part to be tightened		Screw size	Tightening torques		
			N·m	kgf·m	ft·lb
Shift rod detent bolt		—	18	1.8	13.3
Flushing hose adapter screw		ø6	5	0.5	3.7
Upper mounting nut		—	24	2.4	17.7
Upper case plug		—	27	2.7	19.9
Upper case bolt	1st	M8	21	2.1	15.5
	2nd		21	2.1	15.5

Part to be tightened	Screw size	Tightening torques		
		N·m	kgf·m	ft·lb
Engine oil drain bolt	—	27	2.7	19.9
Exhaust manifold bolt	M6	11	1.1	8.1
Steering arm stud bolt	—	20	2.0	14.8
Friction piece bolt	M6	3.9	0.39	2.88
Anode bolt	M6	8	0.8	5.9
Self-locking nut	—	22	2.2	16.2
Trim sensor cam screw	M6	2	0.2	1.5
Grease nipple	—	3	0.3	2.2

PTT unit

Part to be tightened	Screw size	Tightening torques		
		N·m	kgf·m	ft·lb
PTT motor assembly bolt	M6	7	0.7	5.2
Valve lock screw	—	6	0.6	4.4
Main valve	—	11	1.1	8.2
Manual valve	—	3	0.3	2.2
Gear pump bolt	M4	4	0.4	3.0
Gear pump housing bolt	M6	9	0.9	6.6
Tilt piston bolt	M10	61	6.1	45.0
Cylinder end screw	—	90	9.0	66.4
Reservoir cap	—	7	0.7	5.2

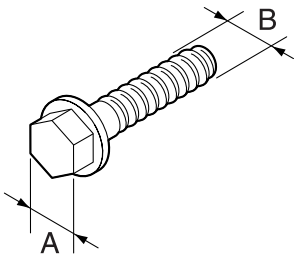
Optional equipment

Part to be tightened	Screw size	Tightening torques		
		N·m	kgf·m	ft·lb
Nipple	—	23	2.3	17.0
Water pressure sensor	—	18	1.8	13.3
Speed sensor	—	18	1.8	13.3

General tightening torque

This chart specifies the tightening torques for standard fasteners with a standard ISO thread pitch. Tightening torque specifications for special components or assemblies are provided in the applicable sections of this manual. To avoid warpage, tighten the multi-fastener assemblies in a crisscross fashion and progressive stages until the specified torque is reached. Unless otherwise specified, torque specifications require clean, dry threads.
Components should be at room temperature.

Width across flat (A)	Screw size (B)	General torque specifications		
		N·m	kgf·m	ft·lb
8 mm	M5	5	0.5	3.7
10 mm	M6	8	0.8	5.9
12 mm	M8	18	1.8	13.3
14 mm	M10	36	3.6	26.6
17 mm	M12	43	4.3	31.7



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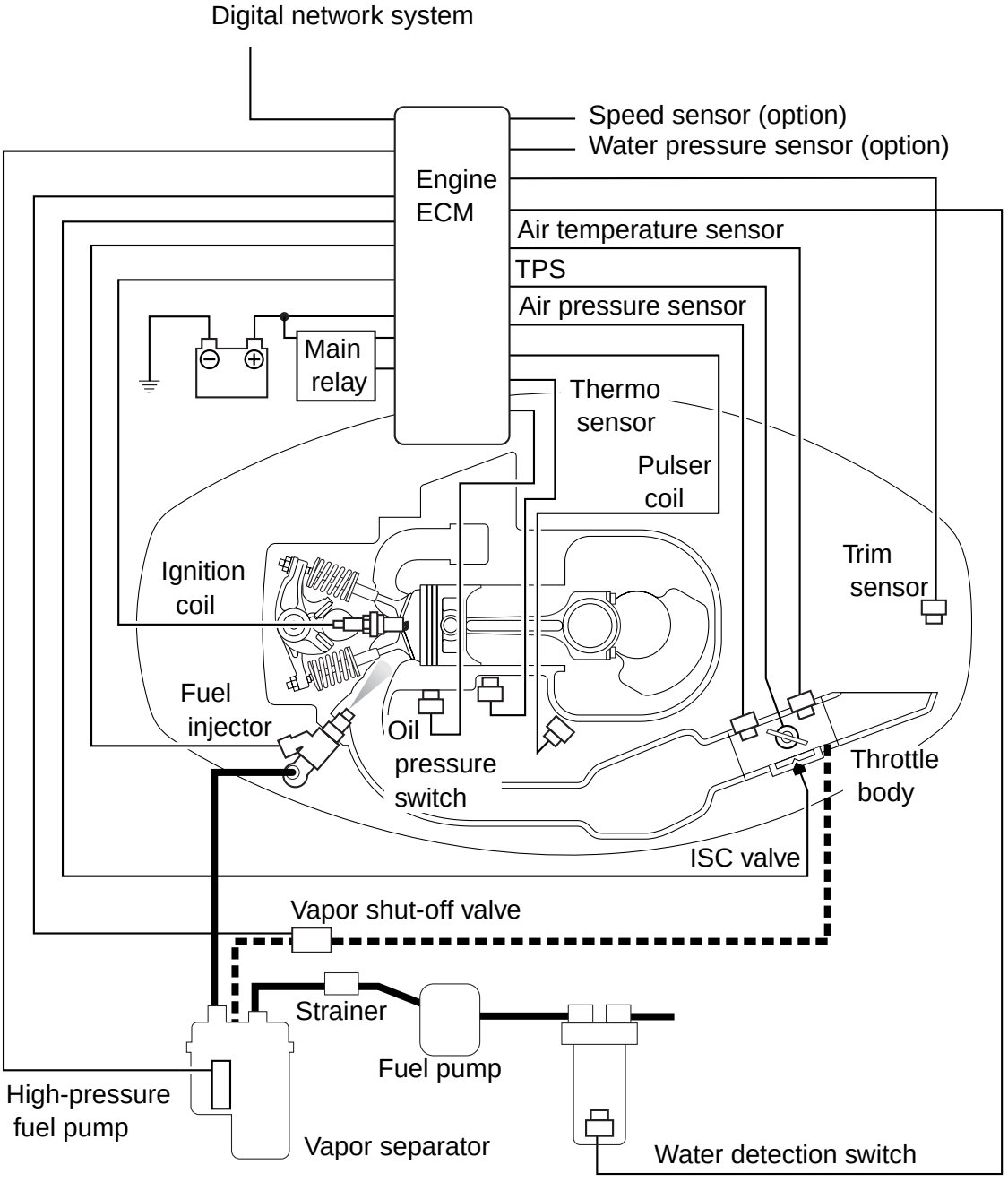
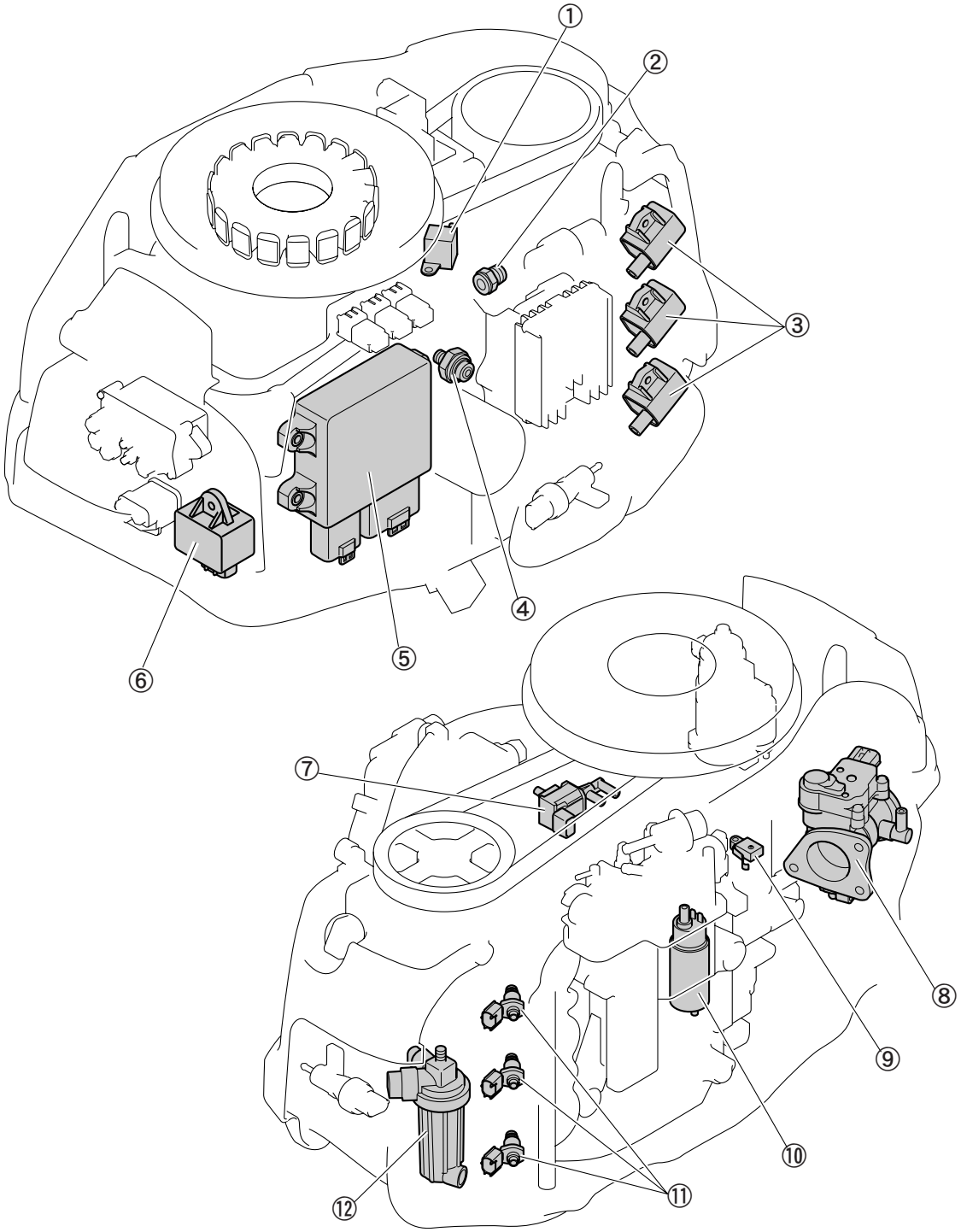
Engine control system

Outline

The Aruana 40 EFI employs an electronically controlled fuel injection system. The engine ECM determines the optimum ignition timing, the fuel injecting timing and volume, and the idle speed based on the signals transmitted from each sensor. Besides, the engine ECM has a self-diagnosis function to perform failure diagnosis by using the YDIS.





① Pulser coil
② Thermo sensor
③ Ignition coil
④ Oil pressure switch
⑤ Engine ECM
⑥ Main relay
⑦ Vapor shut-off valve
⑧ Throttle body (built-in TPS, air pressure sensor, air temperature sensor, ISC valve)
⑨ Neutral switch
⑩ High-pressure fuel pump
⑪ Fuel injector
⑫ Fuel filter (built-in water detection switch)

Engine ECM control systems

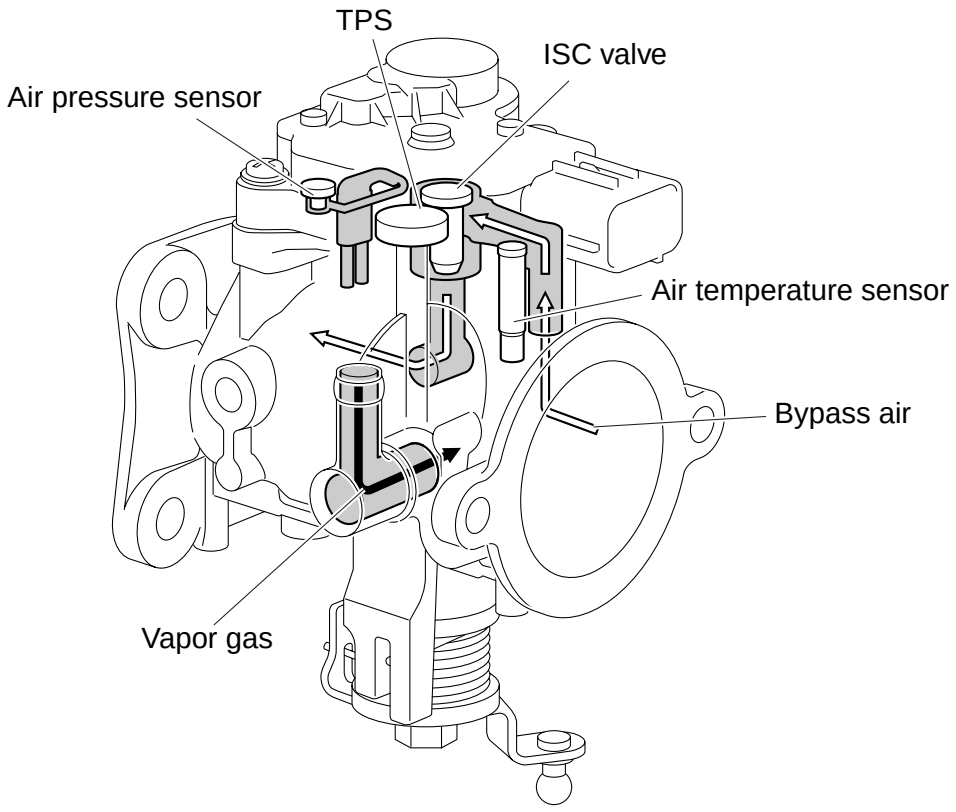
Ignition timing control	Adjusts the ignition timing according to the engine operating conditions. See “Ignition timing control” (2-6).
Fuel injection control	Adjusts the injecting timing and volume according to the engine operating conditions. See “Fuel injection control” (2-7).
Idle speed control	During idle, the engine ECM controls the ISC valve opening by adjusting the stepping motor positions in order to achieve the target idle speed. When reducing speed, the control system closes the ISC valve, and also initializes the valve position by returning it to the fully closed position when the engine start switch is turned to “OFF.”
Fuel pump control	Keeps the high-pressure fuel pump in operation for 3 seconds after the engine start switch is turned to “ON” and during engine operation.
Vapor shut-off valve control	Performs duty controls of the vapor shut-off valve between the fully open and the fully closed positions to decide the engine intake volume of fuel evaporation gas depending on the engine operating conditions. As the engine speed increases, intake volume of fuel evaporation gas increases. On the contrary, the valve closes at engine start.
Tachometer output	6 pulses of digital and analog outputs per crankshaft revolution.
Alert buzzer output	The buzzer comes on when overheat or low oil pressure is detected, when the engine is cranked while the engine shut-off switch is “ON,” or when the gear is shifted to the N position with the engine start switch “ON” and the water detected in the fuel filter.
Alert indicator output	The alert indicator will turn on when overheat is detected or oil pressure gets too low. The check engine indicator will come on through the failure diagnosis control system when the 6Y8 Multifunction Meter is equipped.
Trouble diagnosis control	The following information will be available by connecting to the YDIS: current diagnosis code, past diagnosis records, current engine operation status, past engine operation status, actuator test, and running hours.
Digital network control	6Y8 Multifunction Meter see “Digital network system” (2-11).
Main relay control	Turns the main relay on and off.

Sensor, switch and actuator

Pulser coil	Detects the engine speed. Detects the crankshaft angle and the piston positions.
TPS	Detects the throttle valve opening.
Air pressure sensor	Detects the intake air pressure.
Air temperature sensor	Detects the intake air temperature.
Oil pressure switch	Detects the oil pressure.
Thermo sensor	Detects the cooling water temperature.
Neutral switch	Detects the neutral position.
Engine shut-off switch	Activates the engine stop function compulsorily.
Fuel injector	Gives the optimum amount of fuel at the optimum timing based on the engine ECM command signals.
Ignition coil	Activates the ignition at the optimum timing based on the signals from the engine ECM.
High-pressure fuel pump	Pressurizes the fuel in the vapor separator, and delivers the fuel to the fuel rail.
ISC valve	Adjusts the amount of intake air entering the engine at idle.

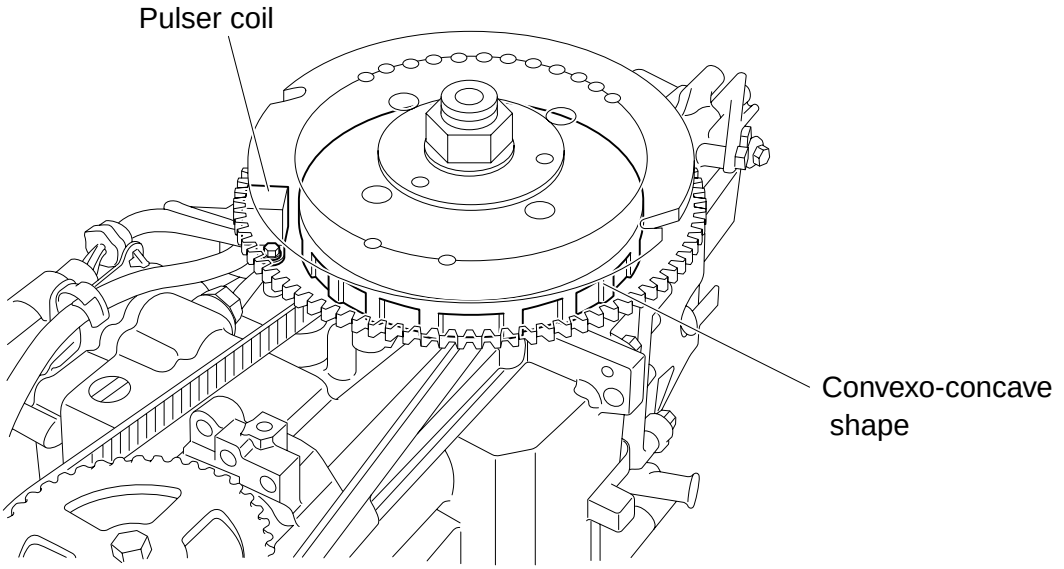
Throttle body

The TPS, the intake pressure sensor, the air temperature sensor, and the ISC valve are incorporated into the throttle body assembly. Idle speed cannot be adjusted manually, because it is controlled by the engine ECM. Adjusting the TPS will not be necessary.

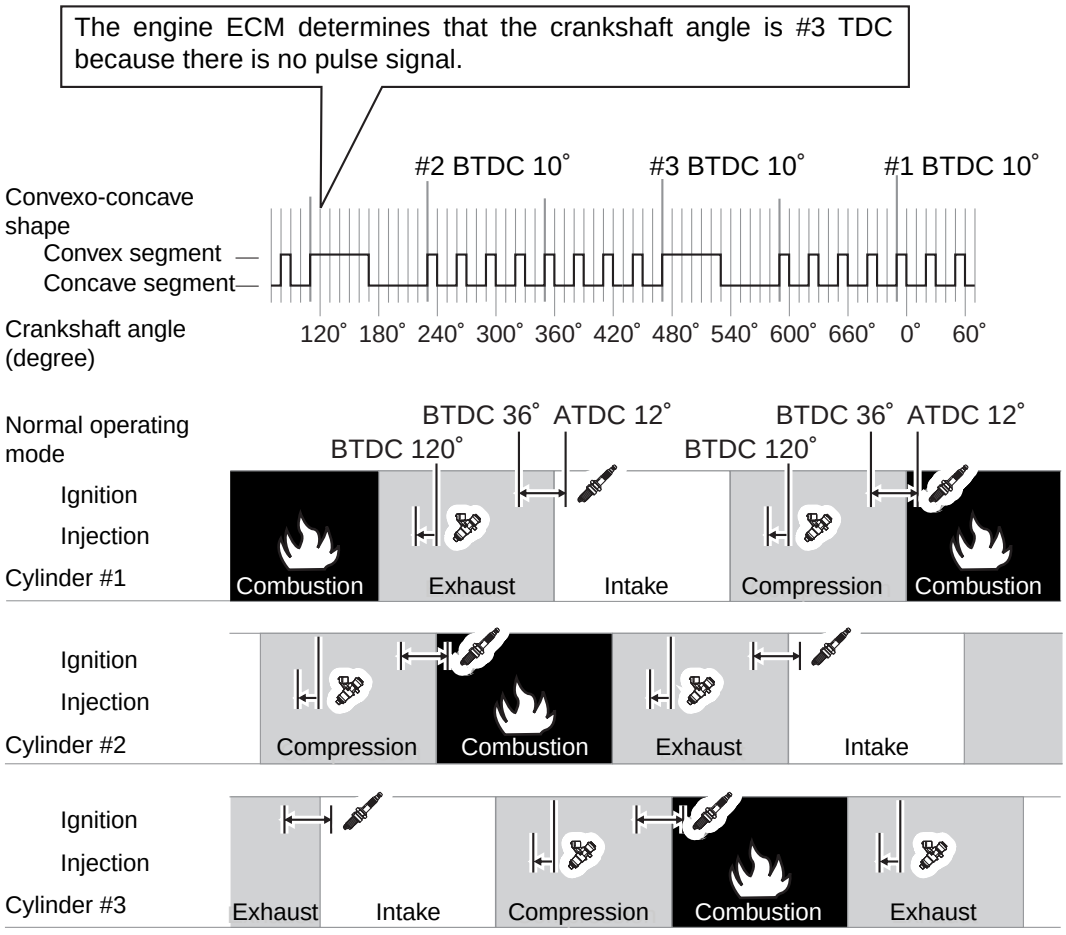


Pulser coil

A single pulser coil determines the engine revolutions, the crankshaft angle, and the direction of the crankshaft rotation. The pulser coil also detects the changes in pulse using the convexo-concave shape in the outer edge of the flywheel magnet.
The engine ECM figures out the crankshaft angle based on the pulse signal changes.

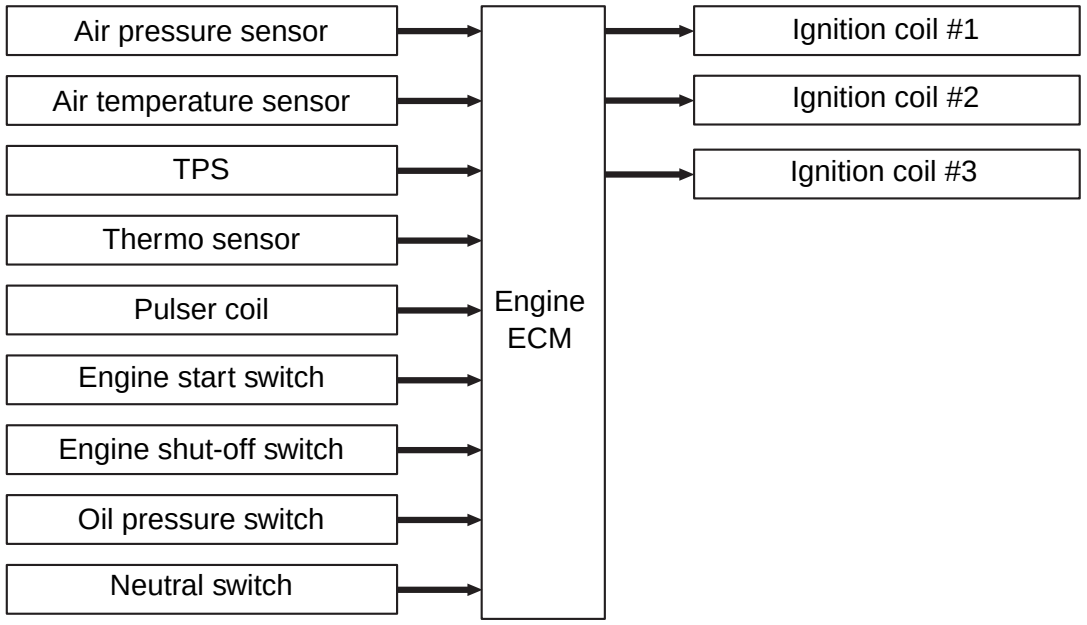


Signals from the pulser coil and the ignition and injecting timing are as follows.
Injection and ignition orders are 1–3–2, but combustion order is 1–2–3.



Ignition timing control

The CDI system of the engine ECM controls the ignition timings.
It determines the optimum ignition timing using the signals transmitted from the sensors and supplies the primary current to the ignition coils.



The ignition timing control includes the start-up, normal operating and engine speed control modes and automatically shifts between these modes depending on the engine operating conditions.
In the start-up mode, the engine ECM fixes the ignition timing until the engine is started.

Start-up mode ignition timing	BTDC 10°

In the normal operating mode, the engine ECM picks up the optimum ignition timing from the map depending on the engine speed.

	Most retarded	Most advanced
Ignition timing control range	ATDC 12°	BTDC 36°

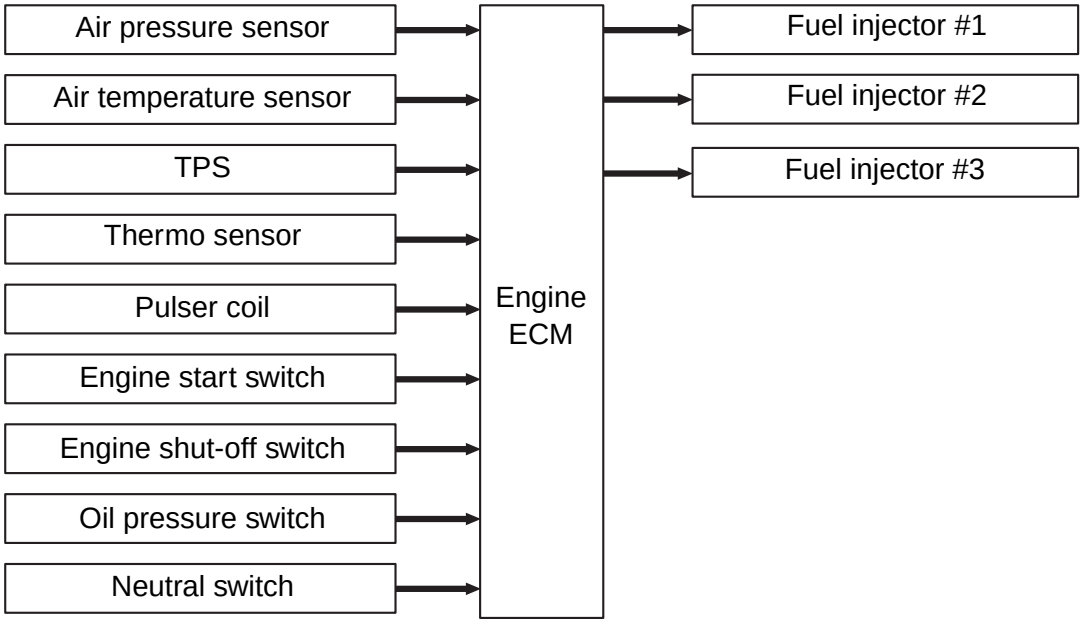
The normal operating mode also compensates the ignition timing by advancing or retarding it depending on the engine operating conditions.

Ignition timing compensations	Corresponding sensor
Compensation after engine start	Thermo sensor, Pulser coil
Idle speed stabilizing	Pulser coil
Compensation at acceleration	TPS, Air pressure sensor
Compensation at deceleration	TPS
Engine speed feedback	Pulser coil

The engine speed control mode functions to limit engine speed increases when over-revving, overheat, or low oil pressure is detected.

Fuel injection control

The engine ECM determines the optimum injecting timing and fuel volume based on the signals from the sensors.



The fuel injection control system includes the start-up, normal operating, and fuel injection cut modes and automatically shifts between these modes depending on the engine operating conditions. Just after the engine start switch is turned to “ON,” the engine ECM transmits signals once to all the injectors simultaneously before the high-pressure fuel pump starts operating to avoid valve sticking of the injectors.
In the start-up mode, the engine ECM keeps injecting fuel simultaneously to all the cylinders at fixed timings until the engine starts.

	Injection timing	Condition
Simultaneous fuel injection at engine start	Cylinder #1 at BTDC 10°	Until cylinder is identified
Synchronous fuel injection at engine start	Each cylinder at BTDC 10°	Until engine start is detected

In the normal operating mode, the injecting timing and volume are determined based on the signals from the pulser coil and the air pressure sensor. This mode includes the synchronous fuel injection in which injectors are operated synchronously with the crank angles, and the non-synchronous fuel injection mode in which injection to all the cylinders is effected by detecting the signals from the sensors.
In the case of the synchronous fuel injection, the optimum injecting timing and amount are selected from the map depending on the engine speed and intake pressure. In the normal operating mode, the system also makes several compensations based on the engine operating conditions.

Fuel injection compensations	Corresponding sensor
Warm up compensation	Thermo sensor
Compensation after startup	Thermo sensor
Compensation at deceleration	TPS, Air pressure sensor
Compensation at acceleration	TPS, Air pressure sensor
Intake air temperature compensation	Air temperature sensor

First, injection end timing is set, and then injection start timing will be calculated according to the determined injection amount.

Injection end timing	Each cylinder at BTDC 120°

In the case of the non-synchronous fuel injection, upon detecting changes in signals that exceed a predetermined level from the TPS or the air pressure sensor, the engine ECM simultaneously transmits injection signals to all the cylinders regardless of crankshaft angle.
In the fuel injection cut off mode, fuel injection is cut off synchronizing with the engine speed control mode of the ignition timing control. See “Ignition timing control” (2-6) and “Engine speed control” (2-8).

Engine speed control

When the engine speed is approaching the upper limit or overheat or low oil pressure is detected, the engine speed control system will stop the fuel injection and ignition to prevent damage to the engine.

When over-revving

Engine speed control starts when engine speed exceeds the specified level.

Engine speed (r/min)	Cylinders to stop injection and ignition
6200 to 6249	#3
6250 to 6349	#3, #2
6350 or higher	#3, #2, #1

When overheat

The control starts when the engine cooling water temperature exceeds the specified level. The injection and ignition to the cylinder #3 are stopped first. If the engine speed does not drop to the target speed, injection and ignition to the cylinders #3 and #2 will be also stopped. Once the cooling water temperature drops to below the specified level, and fully closed throttle is detected, the engine speed control ends and automatically shifts to the normal operating mode.

Overheat is detected and control starts	at 79°C (174°F) or higher
Control is cancelled	at 70°C (158°F) or lower
Cylinders to stop injection and ignition	#3, or #3, #2
Max engine speed	around 3000 r/min

When oil pressure is too low

Engine speed control starts when the oil pressure drops to below the specified value and the oil pressure switch remains on for more than the specified period of time. The injection and ignition to the cylinder #3 is stopped first. If the engine speed does not drop to the target speed, injection and ignition to the cylinders #3 and #2 will be also stopped. Once the oil pressure switch is turned on and fully closed throttle is detected, the engine speed control ends and automatically shifts to the normal operating mode.

Oil pressure switch	ON : 29.4–58.8 kPa (0.294–0.588 kgf/cm^2, 4.3–8.5 psi)
Low oil pressure is detected and control starts	Cooling water temperature is at 40°C (104°F) or higher
Control starts	Once engine speed exceeds 1100 r/min
Low oil pressure duration	1 second
Cylinders to stop injection and ignition	#3, or #3, #2
Max engine speed	around 3000 r/min

When intake malfunctions

The engine ECM will start the engine speed control upon detecting problems with the air pressure sensor when all the following conditions are satisfied: the shift is at the F or R positions, a fully closed signal is sent from the TPS, engine speed exceeds the specified limit, and the ISC valve is in the fully closed position. The injection and ignition to the cylinder #3 is stopped first. If the engine speed does not drop to the target speed, injection and ignition to the cylinders #3 and #2 will be also stopped. Once the throttle is opened and a signal different from that of the fully closed position is sent from the TPS, the mode shifts to the normal operating mode. However, it will restart the engine speed control when closing the throttle.

Engine speed limit	1100 r/min
Cylinders to stop injection and ignition	#3, or #3, #2

Failsafe

When the sensors malfunction, the trouble diagnosis control commands the engine ECM to enter failsafe mode. The trouble diagnosis control system records the trouble codes depending on the engine trouble conditions.

Trou-ble code	Item	LAN gauge display	Trouble conditions to be detected
15	Water temp sensor (Thermo sensor)	C/E	Short or open in the thermo sensor circuit. At engine start: Sets to 5 °C (41 °F), 20 °C (68 °F) or 40 °C (104 °F) depending on the signals from the air temperature sensor (*2). After engine start: maintained at 40°C (104 °F) (*2).
18	Throttle position sensor (TPS)	C/E	Short or open in the TPS circuit. Determines the fully closed position of the throttle based on the signals from the air pressure sensor (*2).
19	Battery voltage	V (*1)	Remains below 12 V for 2 minutes when engine speed is above 2000 r/min.
23	Intake temp sensor (Air temperature sensor)	C/E	Short or open in the air temperature sensor circuit. Operates at 40 °C (104 °F) (*2).
27	Water in fuel	W/F	Neutral switch is at “ON” and water detection switch is at “ON.”
28	Shift position switch (Neutral switch)	C/E	Cranks with the neutral switch “OFF.”
29	Intake press sensor (Air pressure sensor)	C/E	Short or open in the air pressure sensor circuit. Sets a tentative air pressure value based on the engine speed and TPS signals (*2).
37	Intake air passage	C/E	Neutral switch is at “OFF,” throttle is fully closed, ISC valve is fully closed, and engine speed is above 1100 r/min.
44	Engine stop lanyard switch (Engine shut-off switch)	C/E	Cranks when the clip is not inserted.
49	Over cooling	C/E	Cooling water temperature lower than 40 °C (104 °F) and engine speed above 3000 r/min for more than 2 minutes.

(*1) Battery voltage and low battery voltage alert are displayed.
(*2) Control mode in case of malfunction

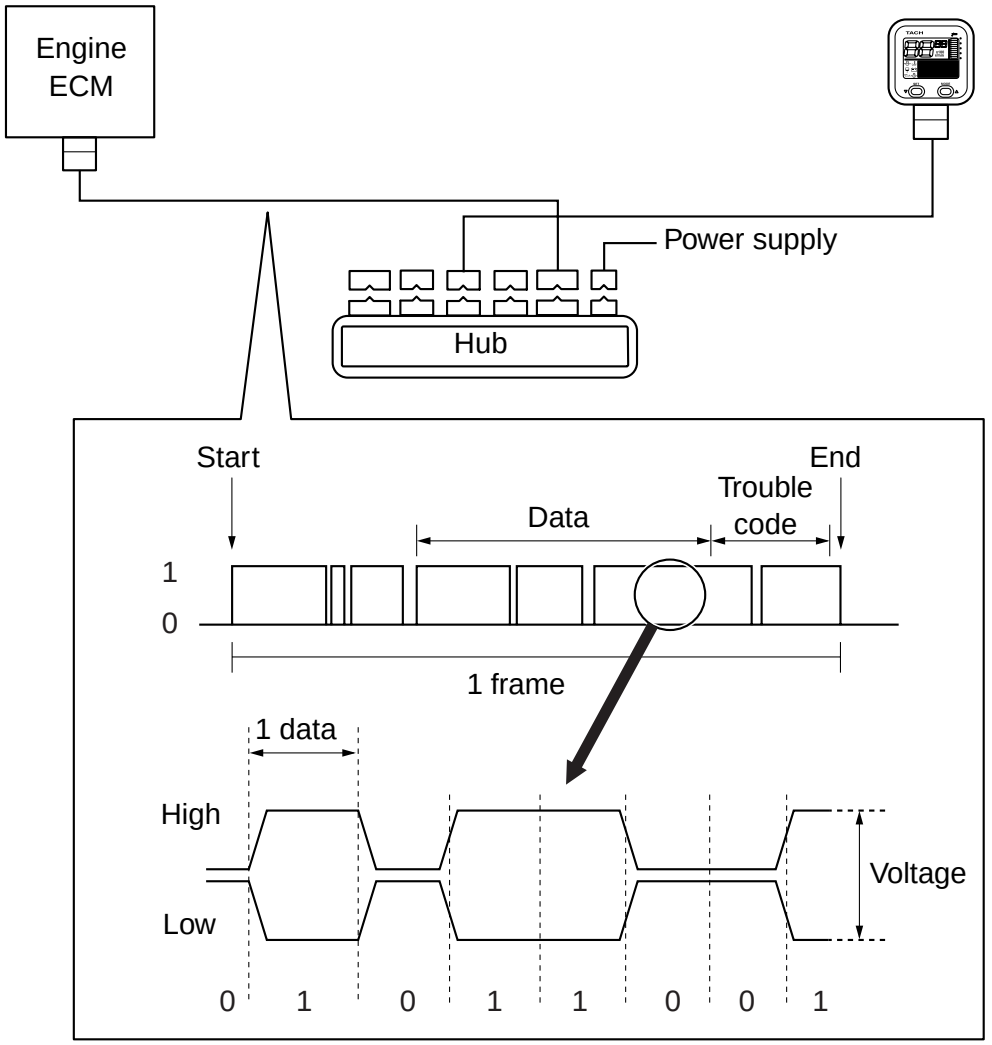
Electronic control system

Digital network system

The Aruana 40 EFI features a digital network system. The 6Y8 Multifunction Meter can also be installed as an option.

In this system, the signals cannot be detected with a circuit tester, as data exchange between connected computers and the meters is being carried out continuously using their built-in ICs. Data 0 or 1 are repeatedly written or registered into the specified address of a frame. When any trouble occurs, trouble code information will also be written into the frame.

The data communication wiring consists of a pair of cables which are out of phase with each other to be free from external impacts.



Variable trolling speed control

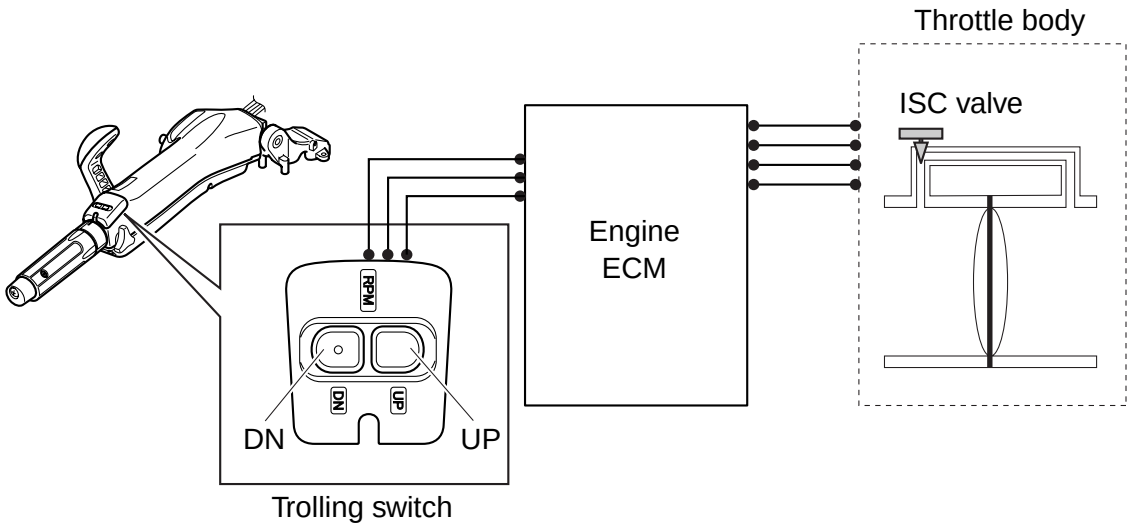
The Multifunction tiller handle model or the 6Y8 Multifunction Meter (Tachometer) allows the trolling speed to be adjusted within a certain range.

Control range	650–900 r/min
Revolutions per step	50 r/min

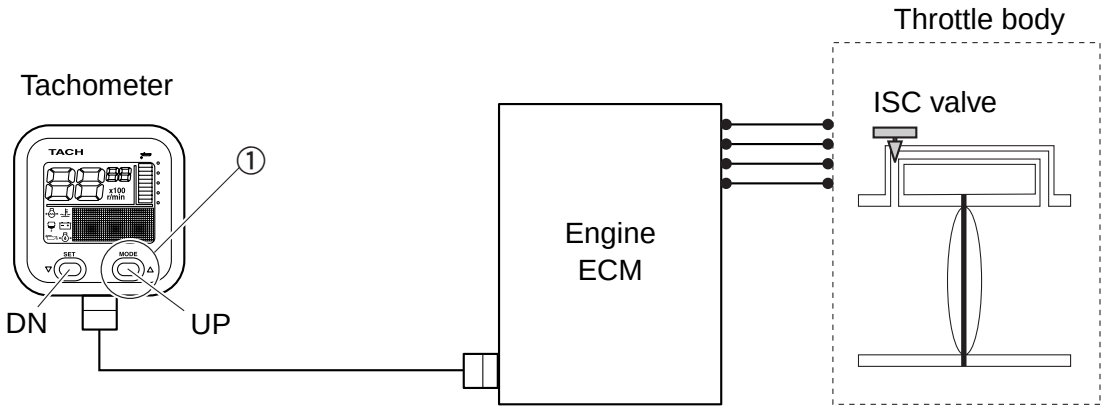
The trolling speed can be adjusted when shifting to the trolling mode by turning on the switch on the tiller handle or operating the mode button ①. For details of the operation of the mode button, see "OWNER'S MANUAL." The engine ECM changes the target engine speed in accordance with the switch operation, and then moves the ISC valve. The variable trolling mode will be canceled when the engine speed exceeds the limit after opening the throttle.

Trolling mode canceled	at 3000 r/min

Multifunction tiller handle model



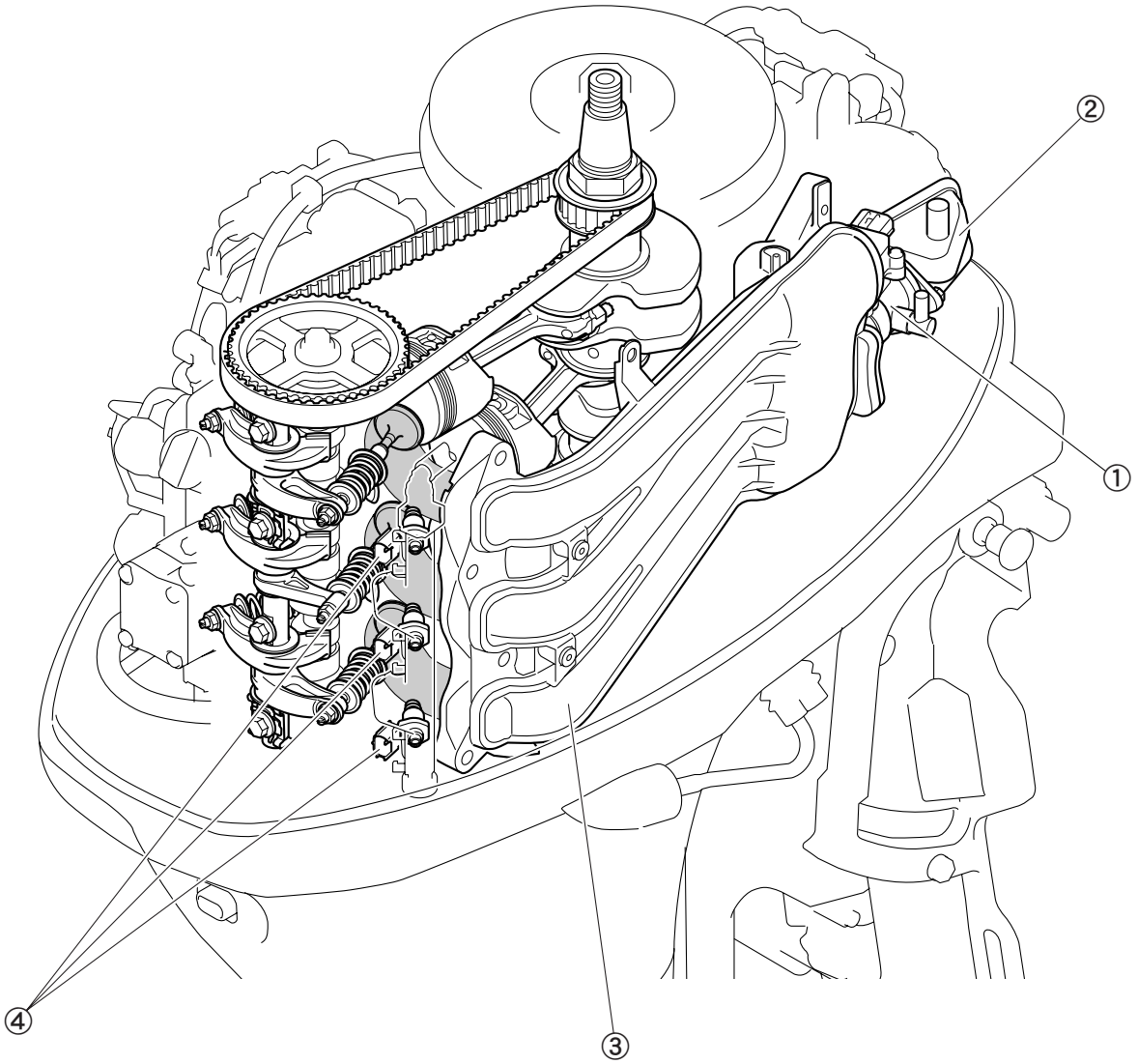
Remote control model



Power unit

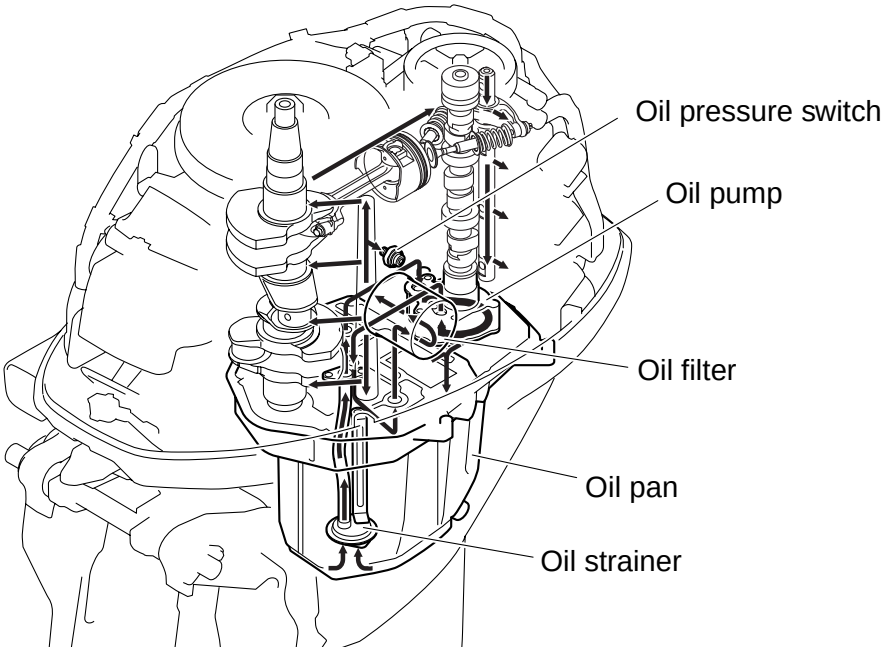
Outline

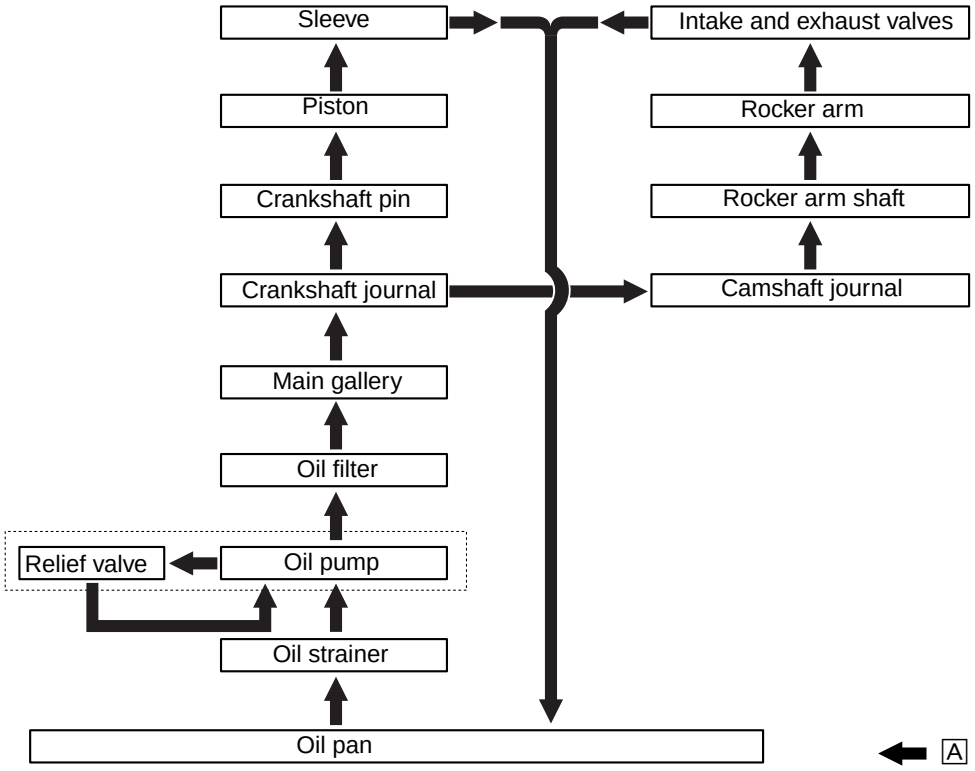
This model has been developed to feature a compact power unit while maintaining the basic layout of the in-line 3-cylinder and the SOHC. Most components such as the cylinder block or the cylinder head have been newly designed to respond to the latest fuel injection control system.
The single valve throttle body ① with various built-in sensors, the plastic air intake silencer ② and intake manifold ③, the proven exhaust emission system and the optimally positioned covers are all incorporated to ensure smooth and quiet operations.
The unit incorporates multipoint injectors ④ with high atomization performance and a computer-controlled vapor reduction system to guarantee sure and reliable engine starts regardless of the ambient conditions.



Lubrication system

System diagram

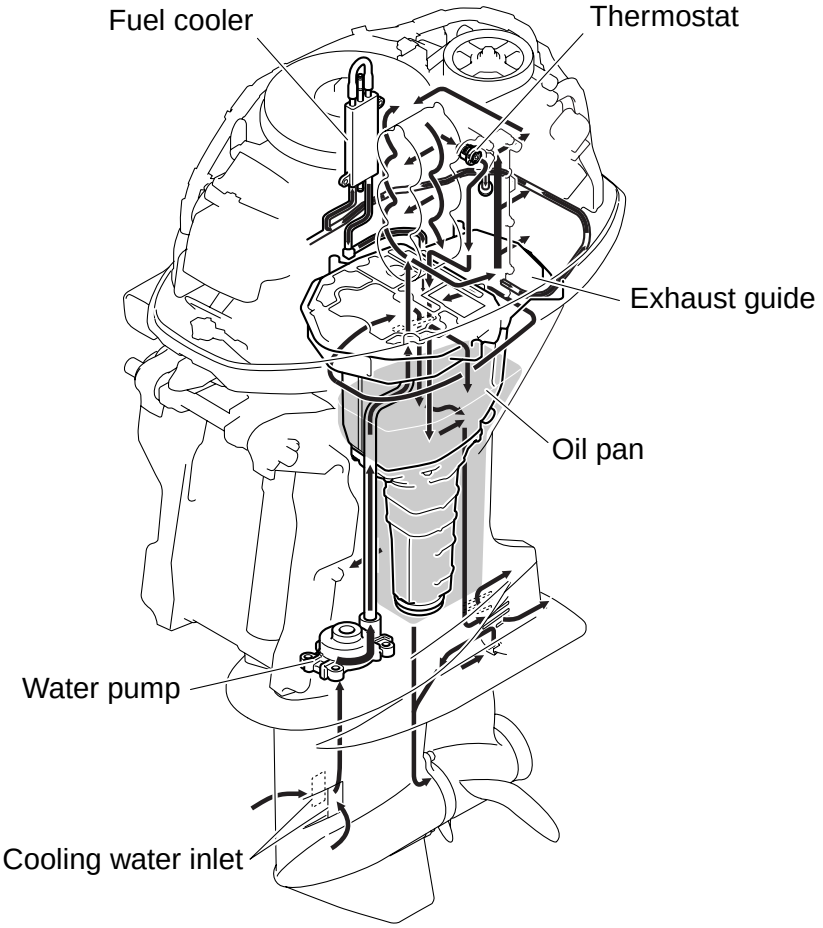


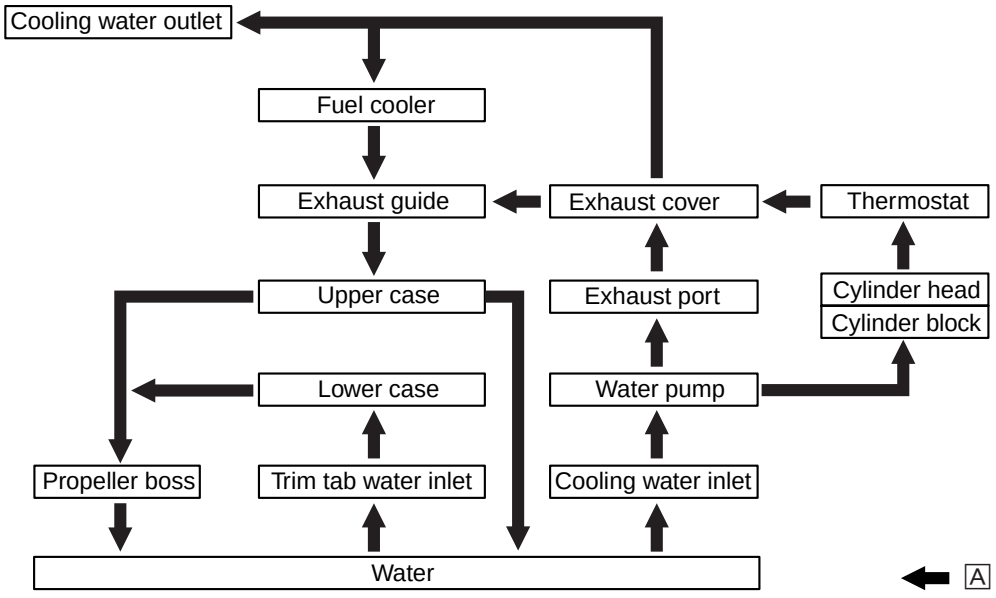


A Engine oil flow

Cooling system

System diagram

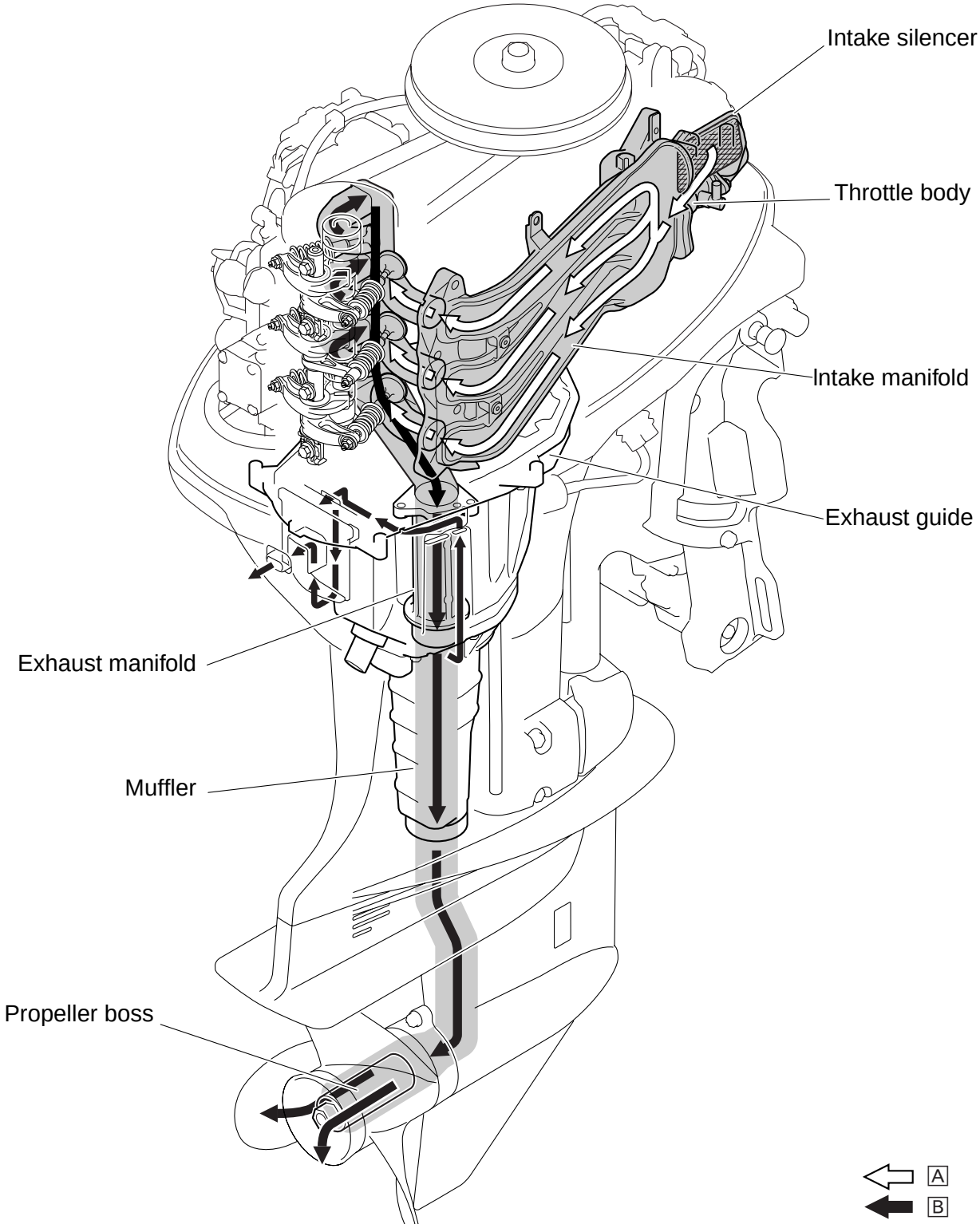




A Cooling water flow

Intake and exhaust system

System diagram



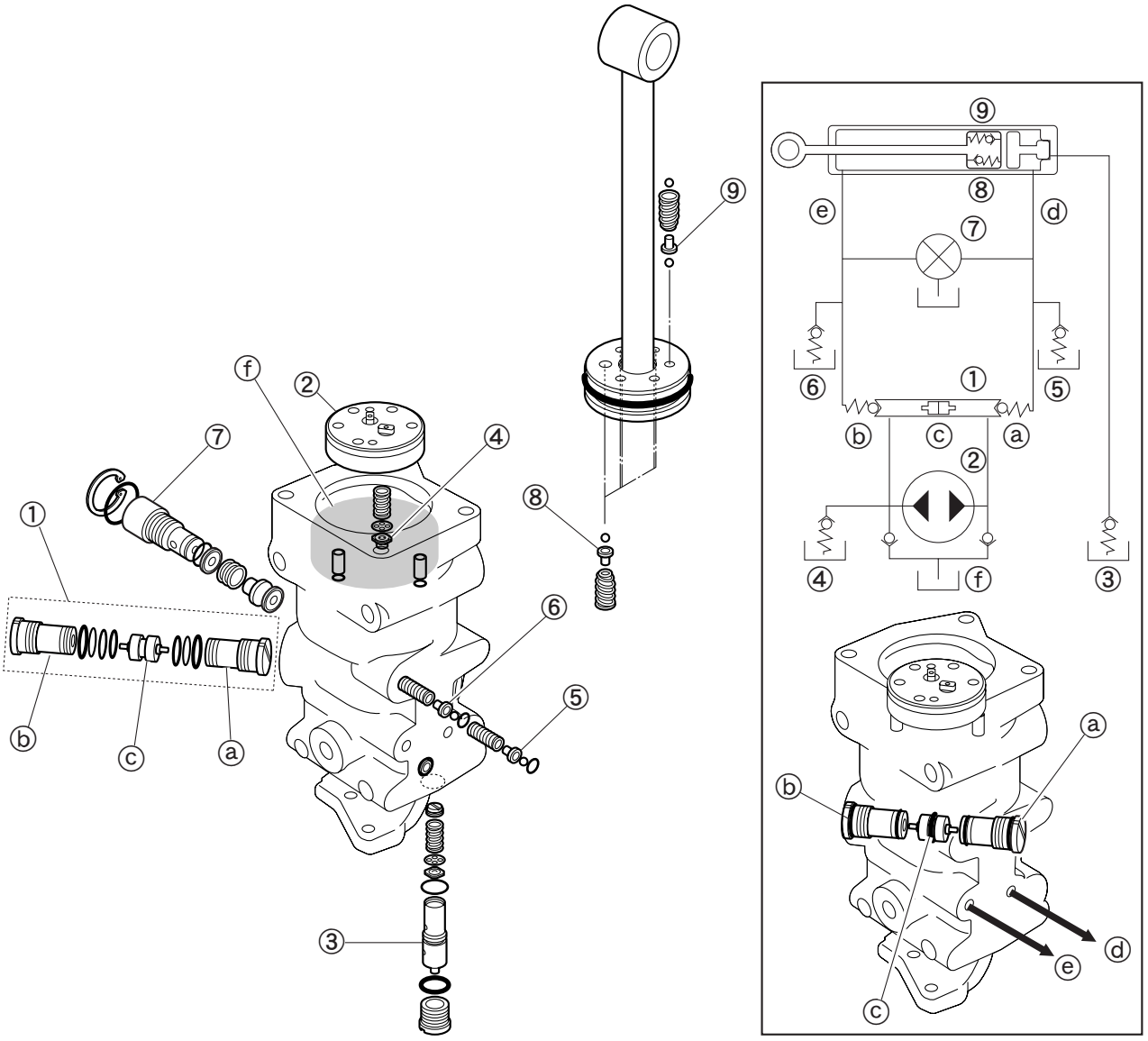
A Intake air flow
B Exhaust gas flow

PTT unit

Outline

The PTT unit consists of the motor unit, the gear pump unit, the valve unit, and the cylinder unit. The main valve ①, which is a component of the valve unit, consists of the up valve ⓐ, the down valve ⓑ and the shuttle piston ⓒ. The motor-driven gear pump ② changes its rotating directions to move the main valve ① and control the PTT fluid flow directions. The relief valves ③, ④ and the protection valves ⑤ and ⑥ are installed at both the upstream and downstream fluid passages to control the fluid pressure. The manual valve ⑦ opens and closes both passages to enable manual operation of the tilt function.

The piston absorbers ⑧ and ⑨ are incorporated into the cylinder unit piston to absorb crash impacts and prevent damage to the PTT unit in case the outboard motor collides with objects while operating.

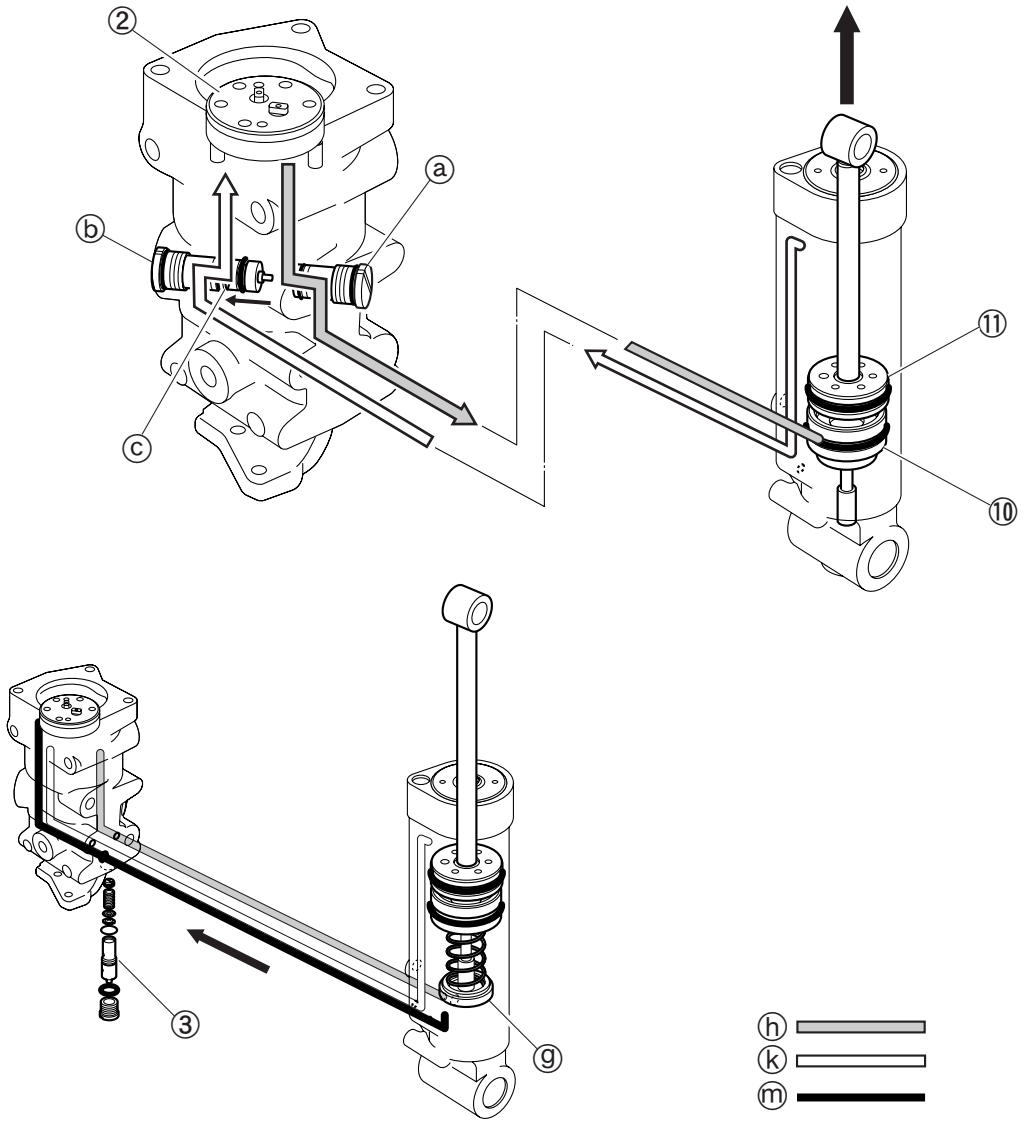


ⓓ Upstream passage
ⓔ Downstream passage
ⓕ Reservoir

Tilt up operation

When the PTT switch is pressed to “UP,” fluid pressure created by the gear pump ② flows into the up side of the shuttle piston ⓒ and pushes the up valve ⓐ allowing it to open. At this point, the fluid pressure forces the shuttle piston ⓒ to slide to the down valve ⓑ. The protrusion of the shuttle piston ⓒ opens the down valve ⓑ, which opens the return circuit. Then, the PTT fluid flows into the lower chamber of the cylinder to force the free piston ⑩ and the tilt ram assembly ⑪ to move upward.

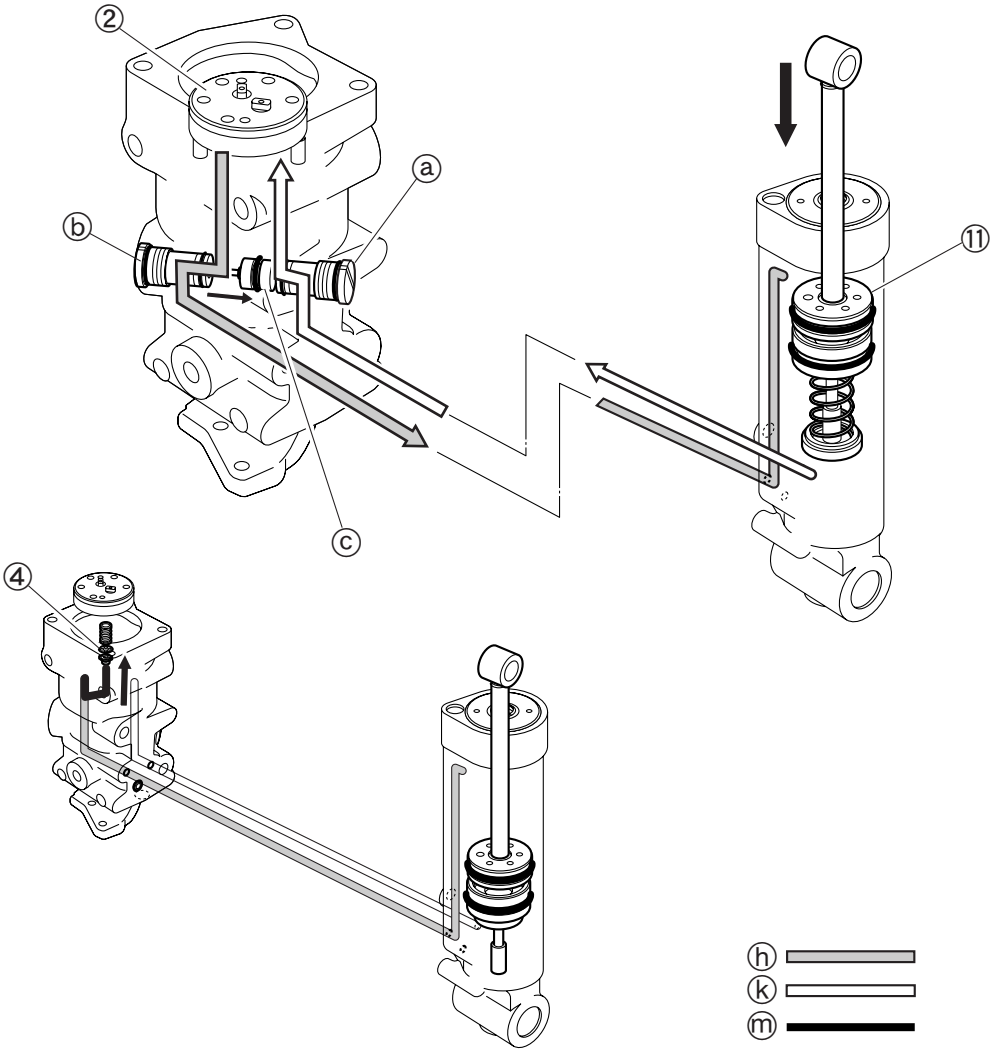
The relief valve ③ of the fluid pressure circuit will open when the fluid pressure exceeds the limit, while the relief valve ③ in the upstream will not work in its trim range because the passage is closed with the free piston rubber seal ⓖ. The up-relief valve opens at 5.4 MPa (54.0 kgf/cm^2, 783.0 psi).



ⓗ Fluid pressure circuit
ⓚ Return circuit
ⓜ Relief circuit

Tilt down operation

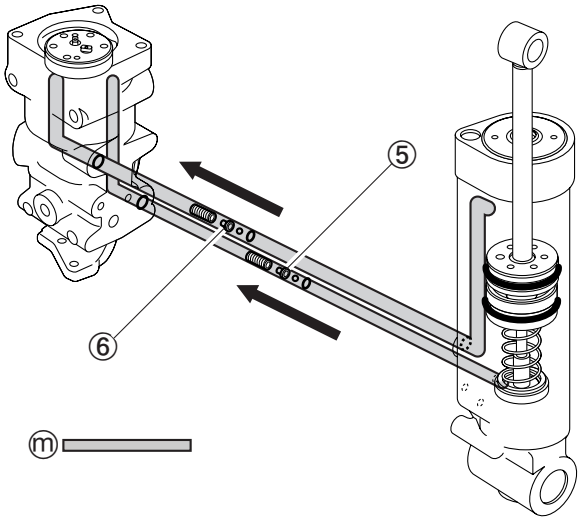
When the PTT switch is pressed to “DN,” fluid pressure created by the gear pump ② flows into the down side of the shuttle piston ⓒ and pushes the down valve ⓑ allowing it to open. At this point, the fluid pressure forces the shuttle piston ⓒ to slide to the up valve ⓐ. The protrusion of the shuttle piston ⓒ opens the up valve ⓐ, which opens the return circuit. Then, the PTT fluid flows into the upper chamber of the cylinder to force the tilt ram assembly ⑪ to move downward.
The relief valve ④ of the fluid pressure circuit will open when the fluid pressure exceeds the limit.
The down-relief valve opens at 2.0 MPa (20.0 kgf/cm^2, 290.0 psi).



ⓗ Fluid pressure circuit
ⓚ Return circuit
ⓜ Relief circuit

Operation in case of malfunctions

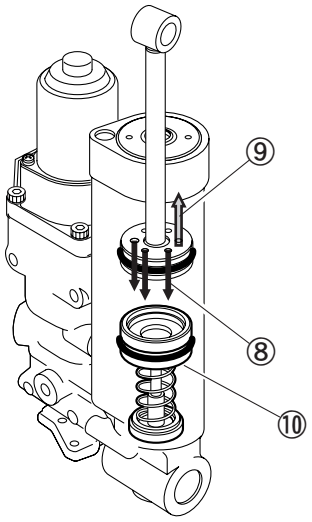
When the fluid pressure in the PTT cylinder exceeds the specified limit, the protection valves (absorber valve pins) ⑤ and ⑥ will open to force the fluid out of the cylinder and to return it to the reservoir and avoid damaging the cylinder. The protection valve opens at 25.0 MPa (250.0 kgf/cm^2, 3625.0 psi).

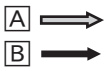


ⓜ Relief circuit

When the outboard motor hits something in the water

When the outboard motor is tilted up after colliding with an object while operating, an upwardly directed force is applied to the tilt ram. This force increases the fluid pressure in the tilt cylinder upper chamber, allowing the 5 piston absorbers ⑧ to start functioning to avoid damaging the PTT unit. For returning, one piston absorber ⑨ functions to return the piston to the position of free piston ⑩. The piston absorber opens at 11.3 MPa (113.0 kgf/cm^2, 1638.5 psi).





A Fluid flow when the outboard returns to the original position.
B Fluid flow when the outboard collides with an object.

Rigging information

Outboard motor installation 3-1

Dimensions 3-2
Exterior E.B.S. 3-2

Exterior E.ST.PT. 3-5
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Installing the shift cable and throttle cable (remote control model) 3-14
Installing the wiring harness (remote control model) 3-16
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Battery requirement 3-21

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Propeller size 3-21
Selection 3-21

Outboard motor installation

⚠ WARNING

- **Overpowering a boat could cause severe instability. Do not install an outboard motor with more horsepower than the maximum rating on the capacity plate of the boat. If the boat does not have a capacity plate, consult the boat manufacturer.**
- **Improper mounting of the outboard motor could result in hazardous conditions such as poor handling, loss of control, or fire hazards. Consult your dealer or a Selva trained person experienced in proper rigging should mount the motor.**

⚠ WARNING

Too much weight on the transom can change the boat's center of gravity, buoyancy, operating balance, or performance which could cause loss of control or swamping. Consult the boat manufacturer for the maximum engine weight allowable on the transom, which is different from the overall boat capacity. Overloading the transom with a motor that is too heavy could also damage the hull, the transom, the deck, or the helm area, as well as the motor and other equipment.

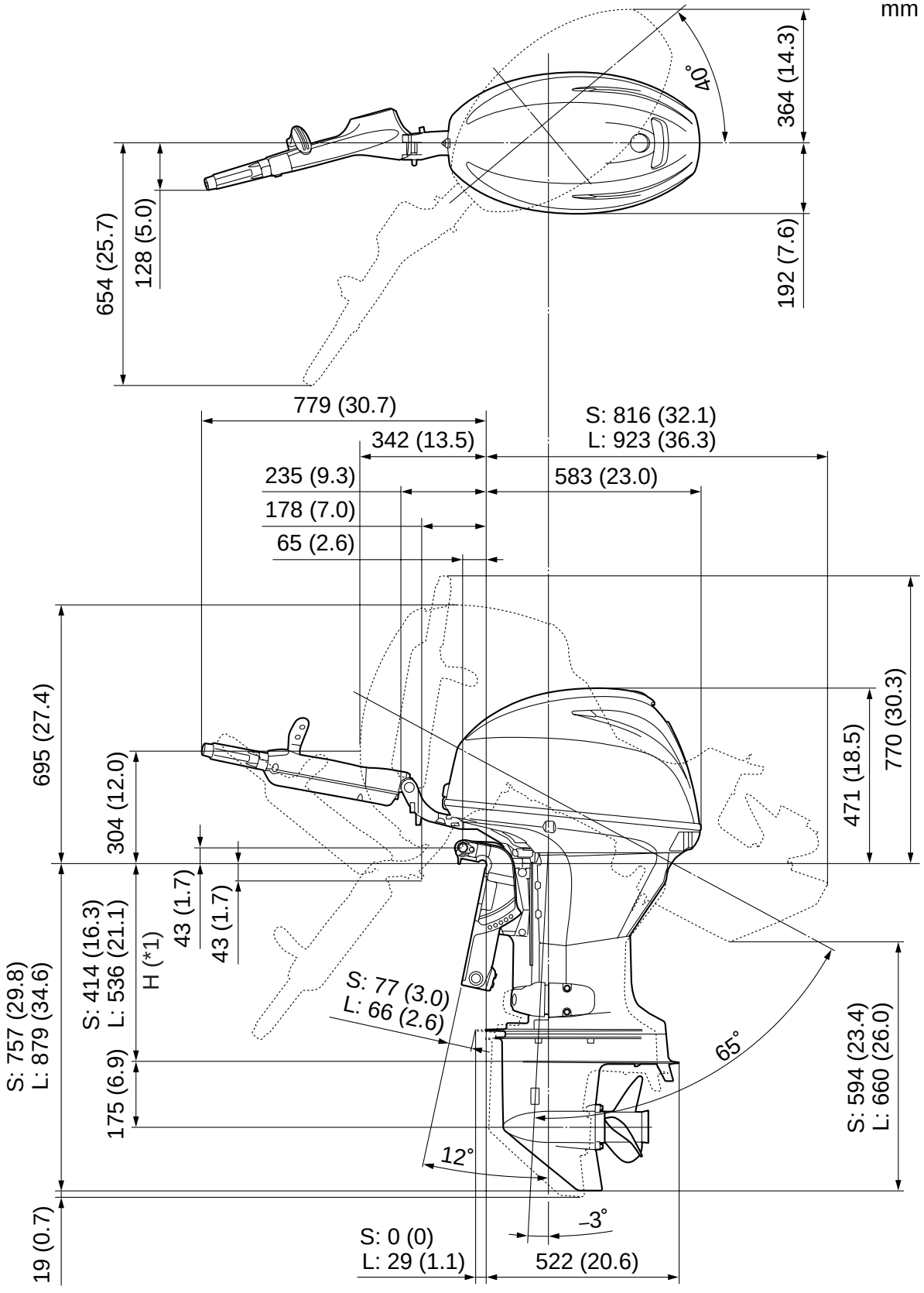
⚠ WARNING

Consult the manufacturer of engine jack plates or brackets before mounting. Excessive loads could damage the plates or brackets, the boat's transom, steering system, or the engine. This could cause loss of control.

Dimensions

Exterior Aruana 40 E.B.S.

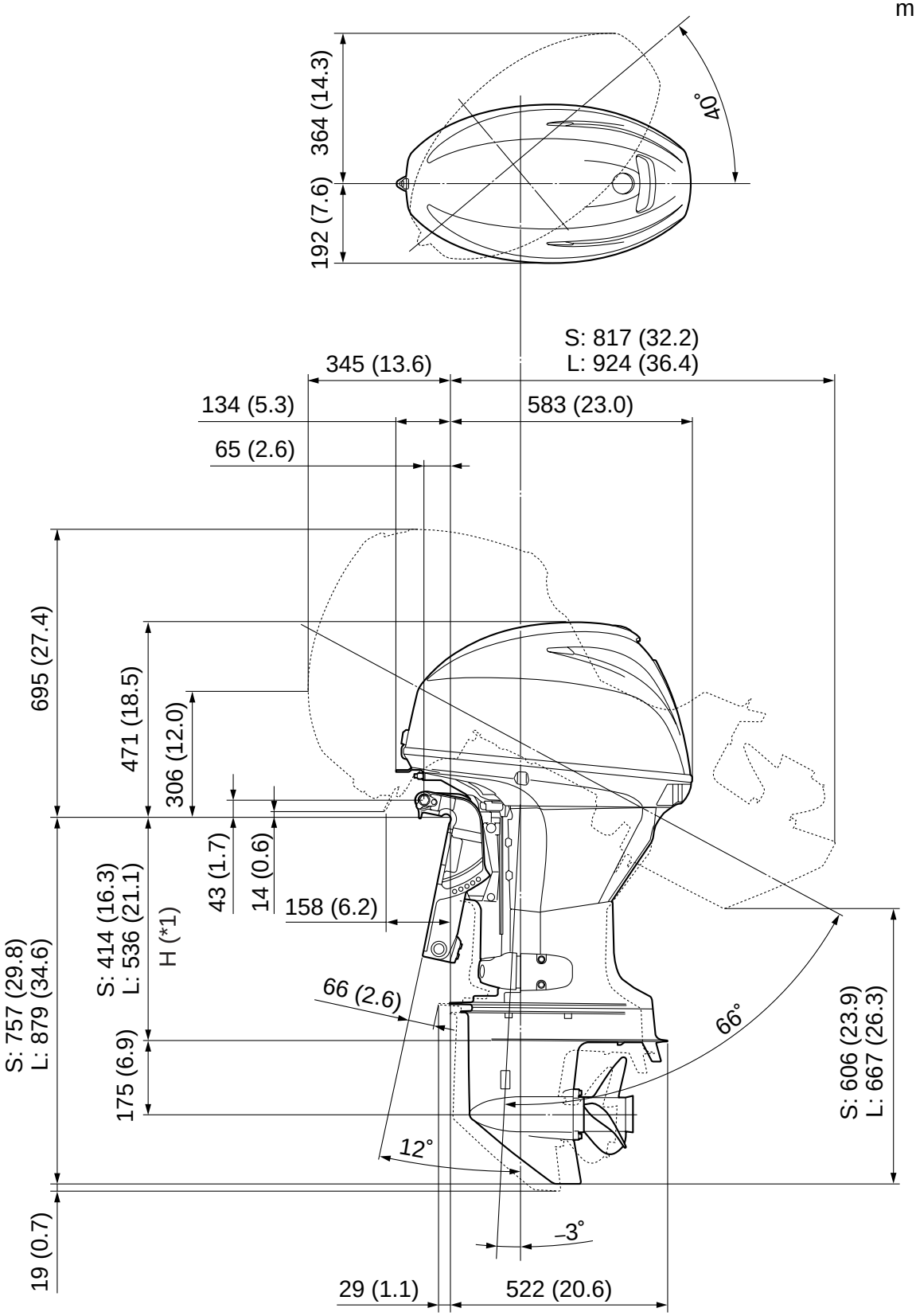
mm (in)



(*1) Transom height

Exterior Aruana 40 E.ST.PT.

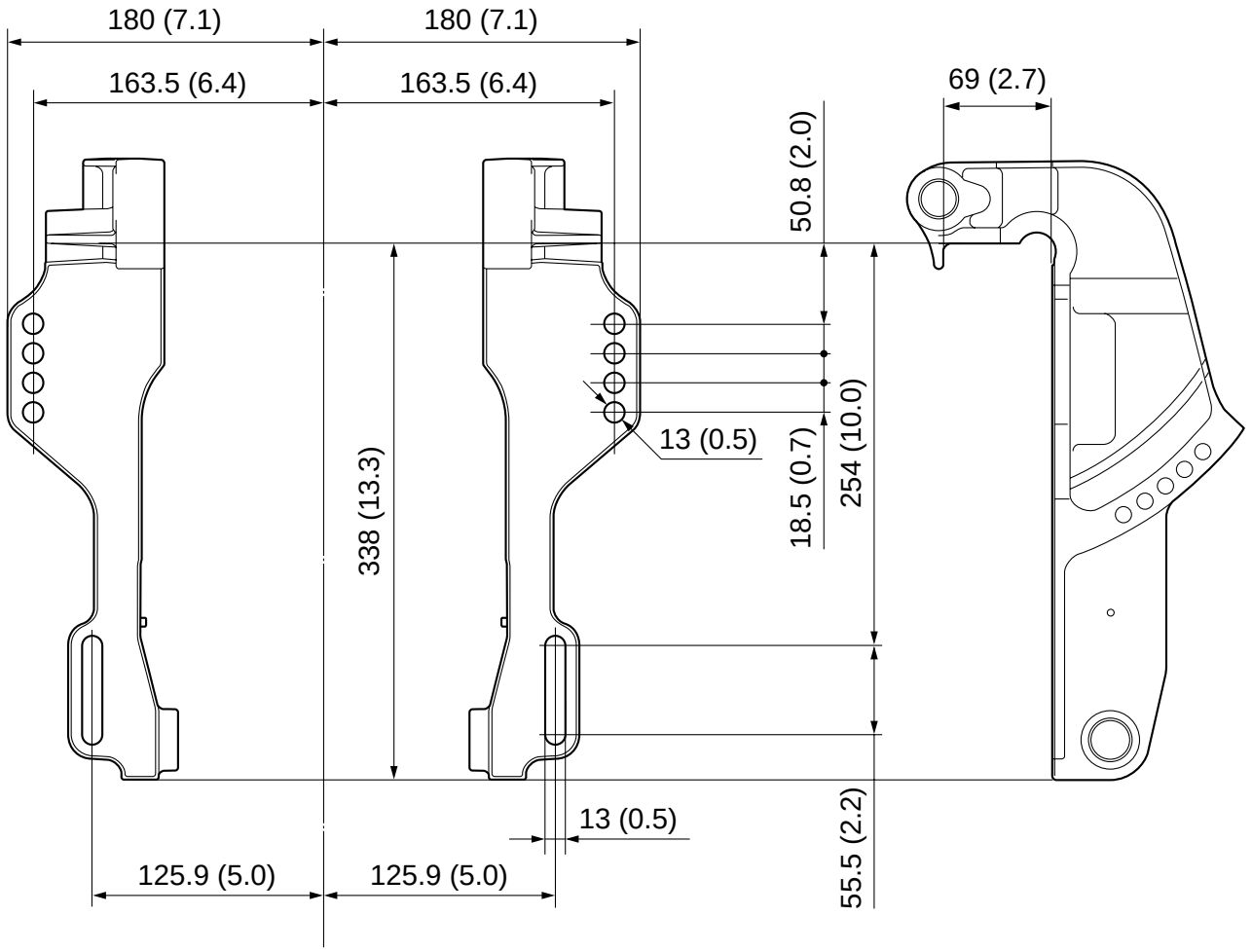
mm (in)



(*1) Transom height

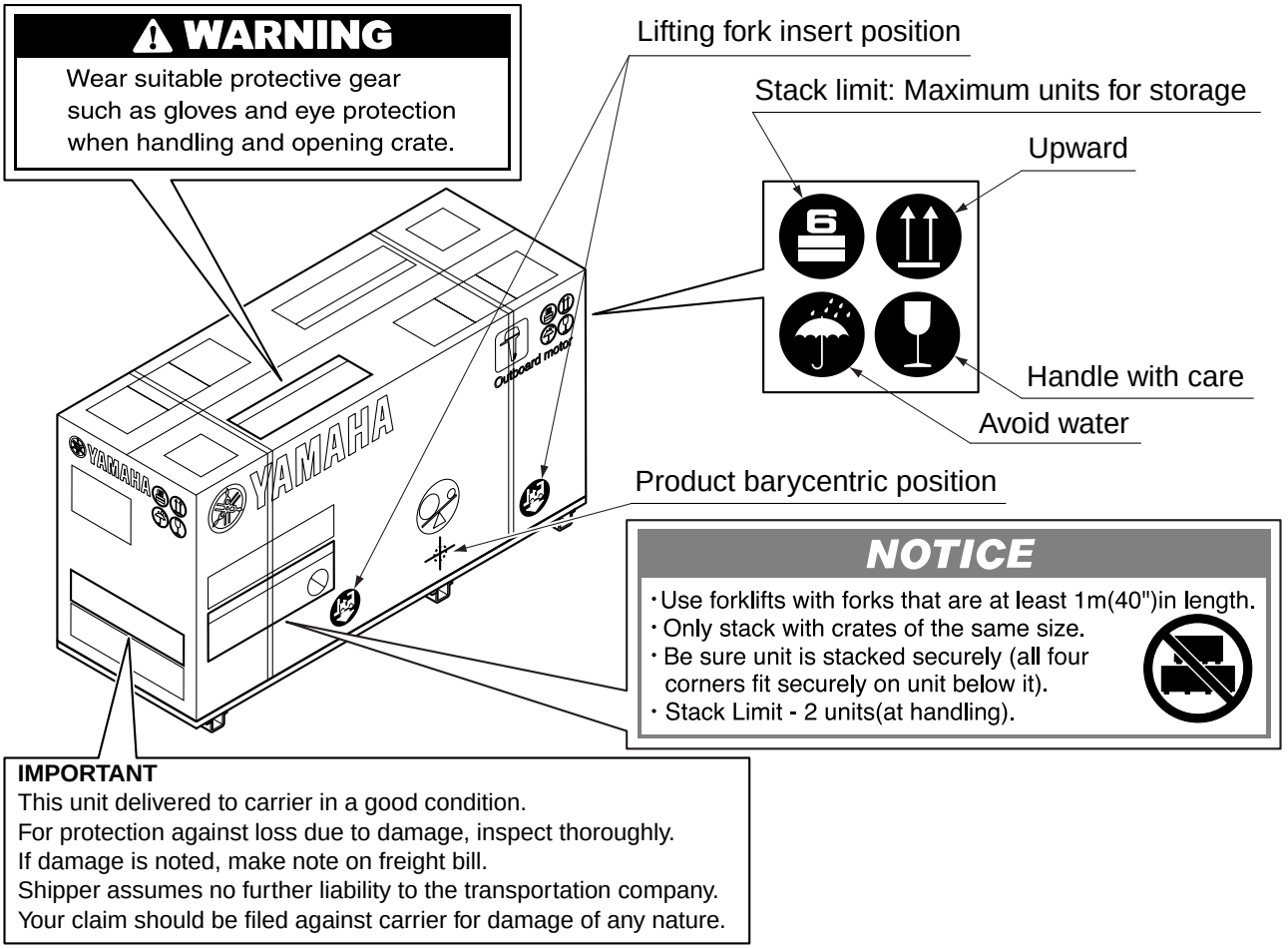
Clamp bracket

mm (in)



Crate top cover pictograph description

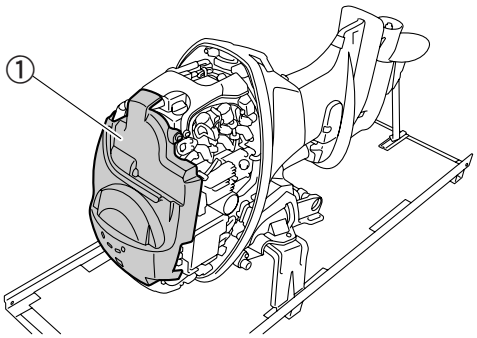
The following pictographs are important signs to handle the crate.
Read the notices and understand what the pictographs mean to avoid damage to the product when handling, transporting and/or keeping the crate.


WARNING
Wear suitable protective gear such as gloves and eye protection when handling and opening crate.
Lifting fork insert position
Stack limit: Maximum units for storage
Upward
Handle with care
Avoid water
Product barycentric position
NOTICE
・Use forklifts with forks that are at least 1m(40")in length.
・Only stack with crates of the same size.
・Be sure unit is stacked securely (all four corners fit securely on unit below it).
・Stack Limit - 2 units(at handling).
YAMAHA
Outboard motor

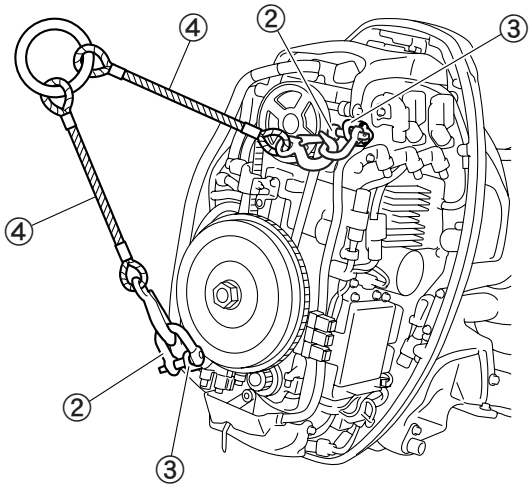
IMPORTANT
This unit delivered to carrier in a good condition.
For protection against loss due to damage, inspect thoroughly.
If damage is noted, make note on freight bill.
Shipper assumes no further liability to the transportation company.
Your claim should be filed against carrier for damage of any nature.

Uncrate procedure

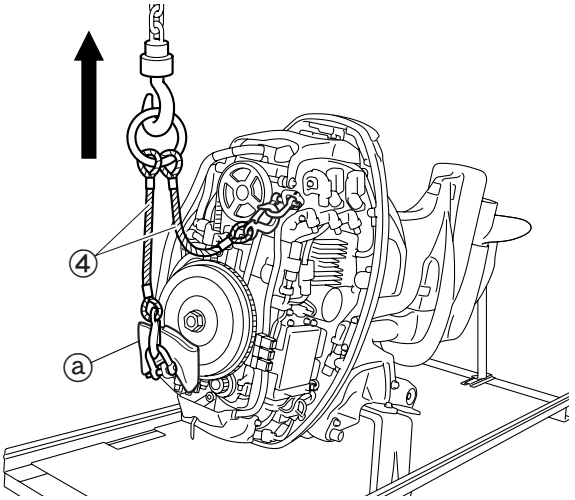
1. Check for any shipping damage.
2. Remove the top cover.
3. Remove all bolts from the bottom plate, and remove the frame. ***NOTICE:*** **Be careful not to cause any damage to the outboard motor.**
4. Remove the wrapping, and check the outboard motor for concealed damage.
5. Remove the top cowling and the flywheel magnet cover ①.



6. Install the shackles ② to the engine hangers ③, and then install the lifting harnesses ④ to the shackles ②.

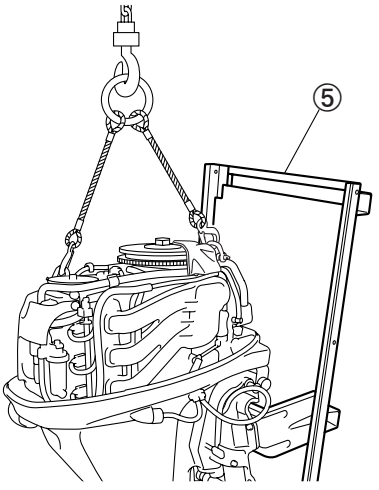


7. Tension the lifting harnesses ④.

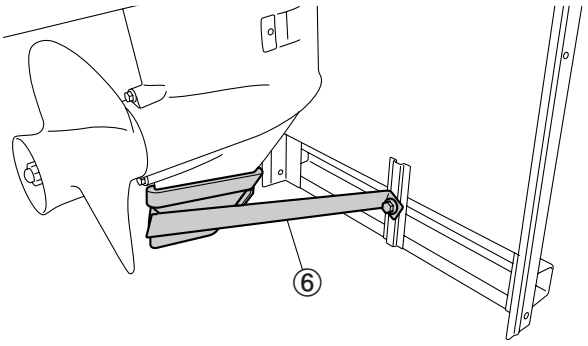


TIP:
Put a rag ⓐ between the flywheel magnet, the lifting harness, and the shackle.

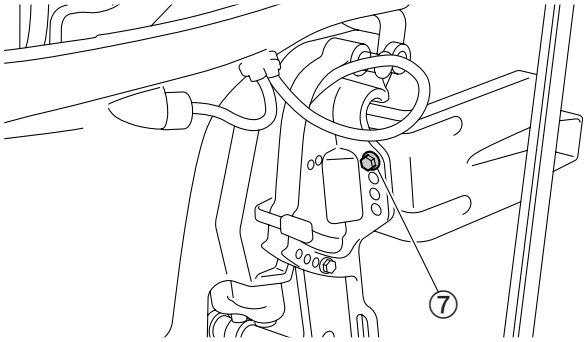
8. Carefully lift up the outboard motor together with the bottom frame ⑤. ***NOTICE:*** **Do not allow the lifting harness to damage any parts of the outboard motor.**



9. Remove the skeg holder ⑥.



10. Remove the bolts ⑦.

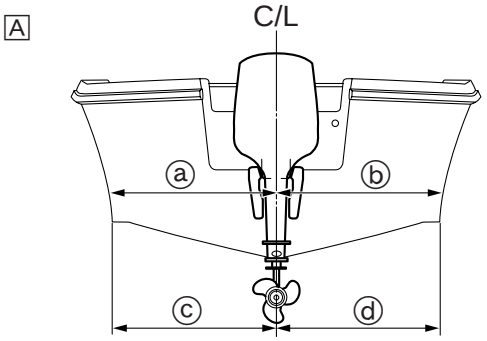


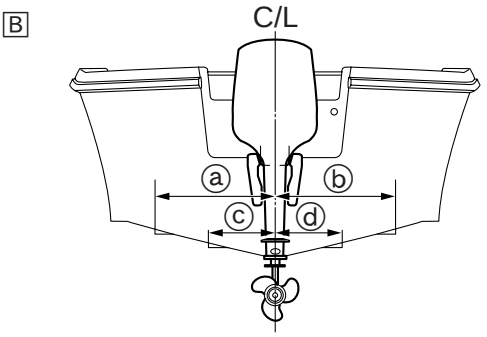
11. Remove the steering retainer, and then install a hydraulic steering cylinder or steering cable following the manufacture's recommendation before the outboard motor is mounted (remote control model).

Mounting the outboard motor

Proper mounting of the outboard motor will mean better performance, maximum reliability, and highest customer satisfaction. This chapter contains the specifications necessary to mount the outboard motor, and may vary slightly depending on the applications.
When mounting the outboard motor, also make sure the outboard motor has the clearance to provide full movement, from both PORT to STBD, as well as during trim and tilt functions. See "Dimensions" (3-2).

1. Set the outboard motor on the vertical centerline of the boat transom.

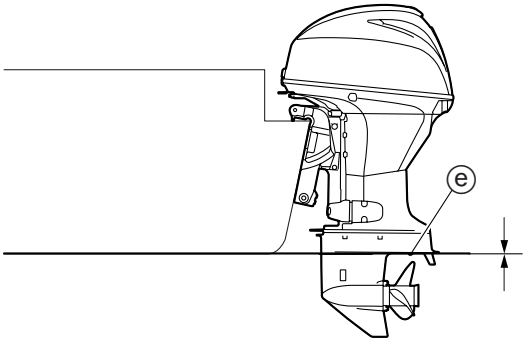




A No strakes hull
B Strakes hull
C/L: Centerline of the transom

TIP:
Double check the measurement distance to verify that the vertical centerline is straight. The distances ⓐ and ⓑ are of equal length. And so are ⓒ and ⓓ.

2. Adjust the outboard motor so that the height of the anti-cavitation plate ⓔ is equal to or slightly above the bottom of the boat transom.

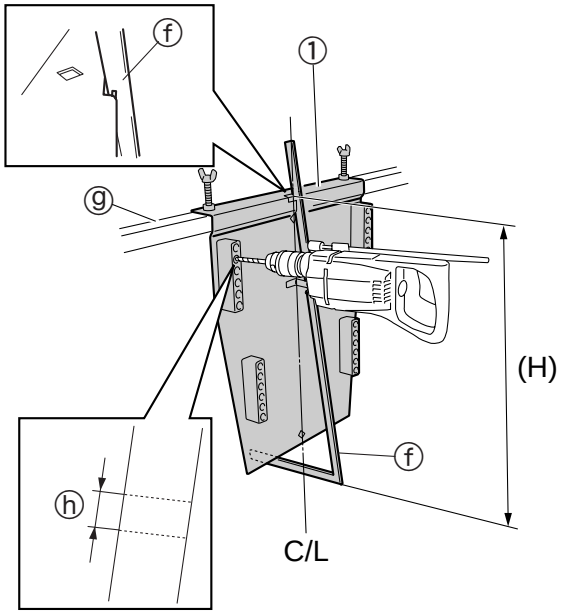


TIP:
This mounting height information is for reference only. It is impossible to provide complete instructions for every possible boat and outboard motor combination.

3. Adjust the scale ⓕ to the transom height (H), and set it on the special service tool ①. Secure the service tool ① to the boat transom by means of a screw or a vise.

TIP:
See "Dimensions" (3-2) for the distance (H).

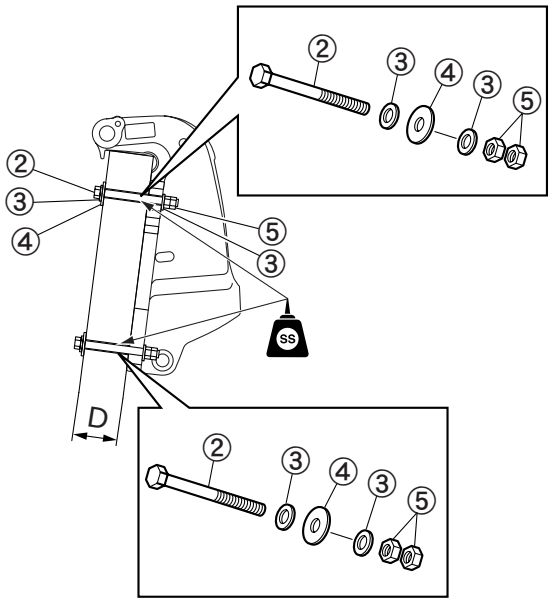
4. When the outboard motor mount position has been determined, mark the best suited 4 symmetrical mounting holes for the boat transom ⑨. Drill the mounting holes vertically on the boat transom using a 13.0 mm (0.5 in) ⓗ drill.



C/L: Centerline of transom

Drilling plate ①: 90890-06783

5. Apply sealant to the mounting holes and secure the outboard motor with the supplied mounting bolts ②, small washers ③, large washers ④, and nuts ⑤. ***NOTICE:*** **Make sure that there is no clearance on the surfaces between the transom and the clamp bracket.**

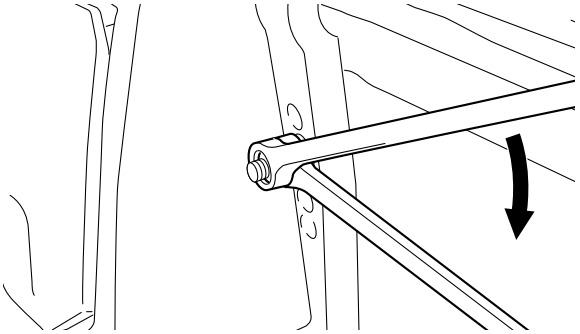


Boat transom thickness (D)	Mounting bolt
65–75 mm (2.56–2.95 in)	M12 × 105 mm (4.13 in)

TIP:
The second hole from the clamp bracket top is recommended for the upper mounting bolt.

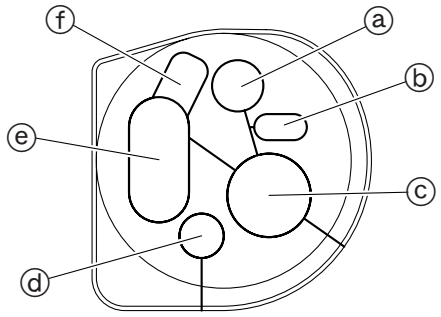
6. Secure the bolts, and firmly tighten the nuts only until the clamp bracket does not bite into the boat transom.

7. Firmly tighten the locknuts.



Mounting the rigging grommet

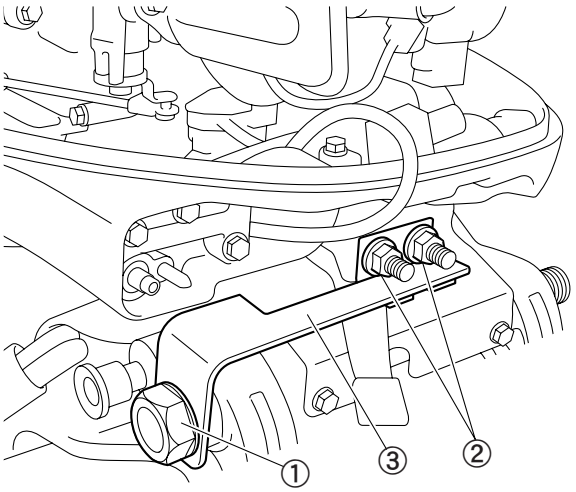
Rigging grommet description



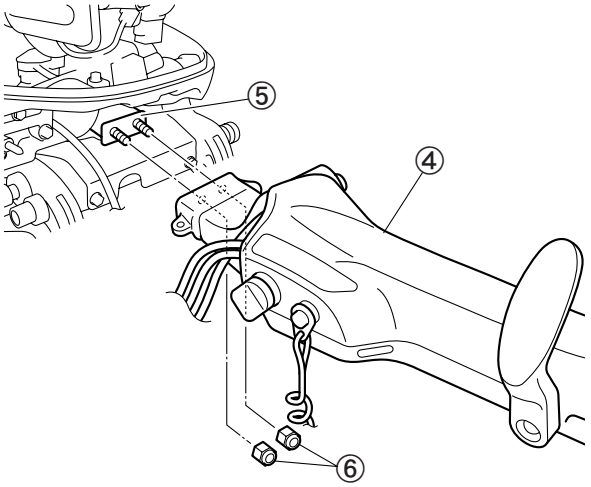
ⓐ Alert indicator harness
ⓑ Trolling switch harness
ⓒ Extension wiring harness
ⓓ Speedometer hose
ⓔ Battery cable
ⓕ 6Y8 Multifunction Meter harness/Immobilizer wiring harness (for European market)

Installing the tiller handle

1. Remove the nut ① and the nuts ②, and then remove the steering retainer ③.



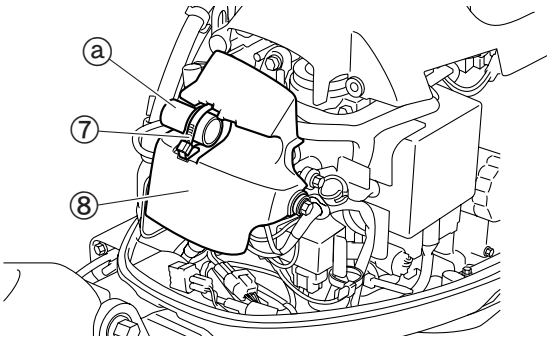
2. Install the tiller handle assembly ④ to the steering arm ⑤, and then tighten the tiller handle nuts ⑥ to the specified torque.



Tiller handle nut ⑥:
37 N·m (3.7 kgf·m, 27.3 ft·lb)

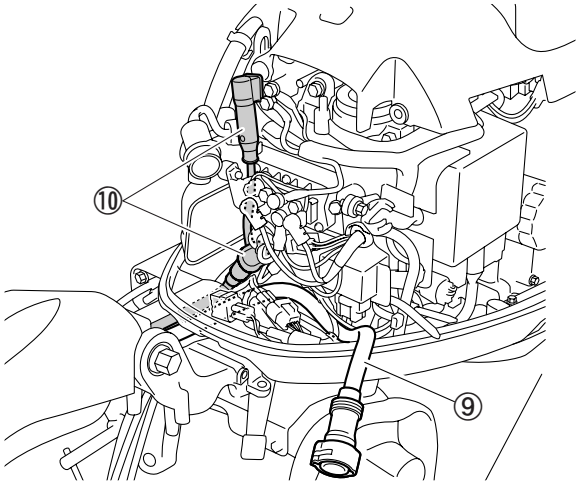
3. Remove the plastic tie ⑦, and then remove the main wiring harness coupler ⓐ.

4. Remove the cover ⑧.



5. Insert the extension wiring harness ⑨ into the bottom cowling, and then insert the battery cables ⑩ into the bottom cowling.

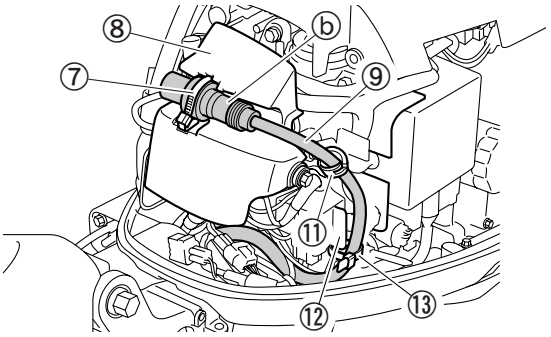
6. Install the battery cables ⑩.



7. Install the cover ⑧.

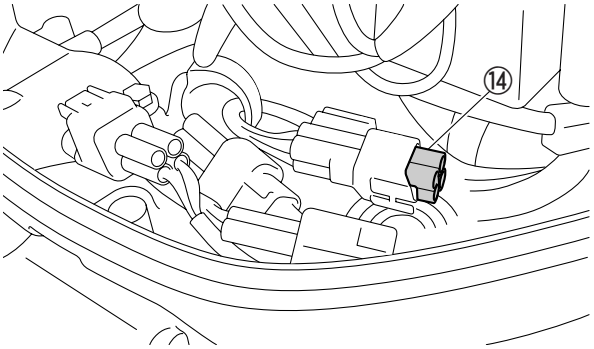
8. Connect the 10-pin coupler ⓑ, and then fasten it to the cover ⑧ with a plastic tie ⑦.

9. Install the extension wiring harness ⑨ to the clamp ⑪, and then fasten the extension wiring harness ⑨ to the bracket ⑫ with a plastic tie ⑬.

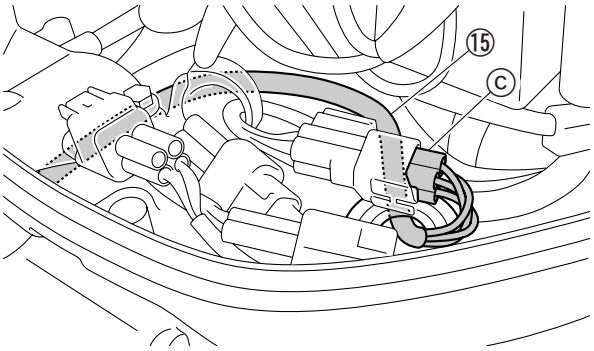


TIP:
Before fastening the extension wiring harness ⑨ to the clamp ⑪ and the bracket ⑫, pull it to prevent loosening.

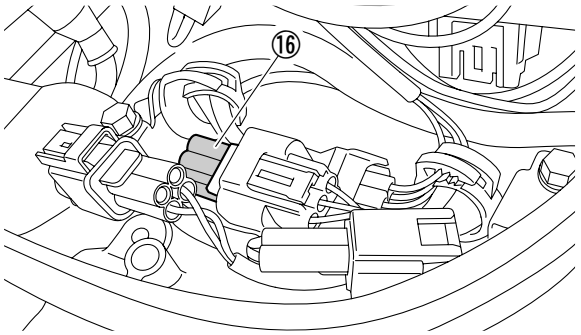
10. Remove the cap ⑭.



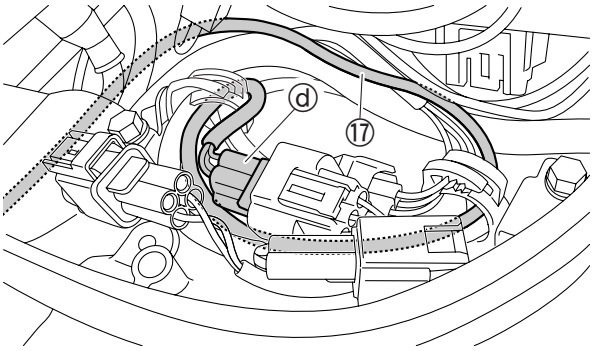
11. Run the alert indicator harness ⑮ into the bottom cowling, and then connect the alert indicator harness coupler ⓒ.



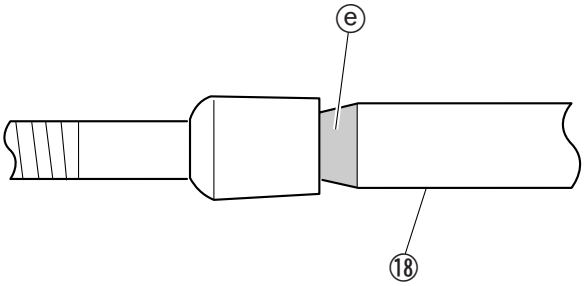
12. Remove the cap ⑯.



13. Run the trolling switch harness ⑰ into the bottom cowling, and then connect the trolling switch harness coupler ⓓ.



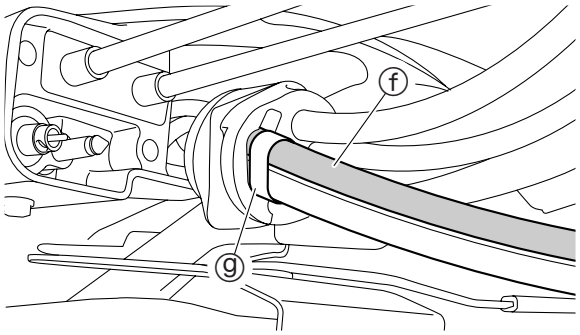
14. Install the shift cable and the throttle cable. See “Installing the shift cable and throttle cable (remote control model)” (3-14).



TIP:
The shape ⓔ identifies the shift cable ⑱.

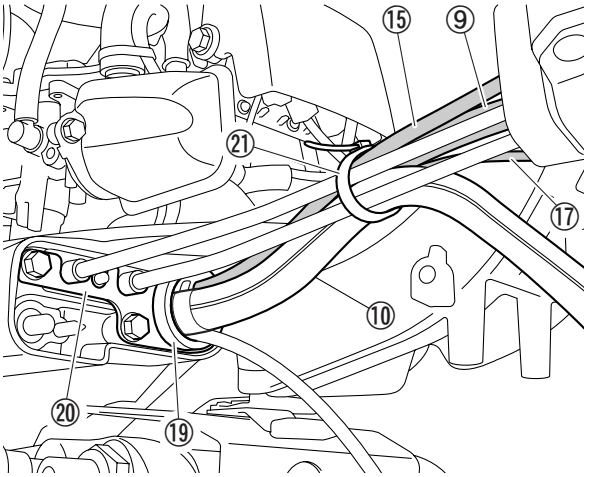
15. Install each harness and cable in the corresponding position on the rigging grommet. See "Rigging grommet description" (3-11).

16. Install the battery cable with the positive battery cable ⓕ up, aligning the white tape ⓖ on the battery cable with the outer end of the rigging grommet.

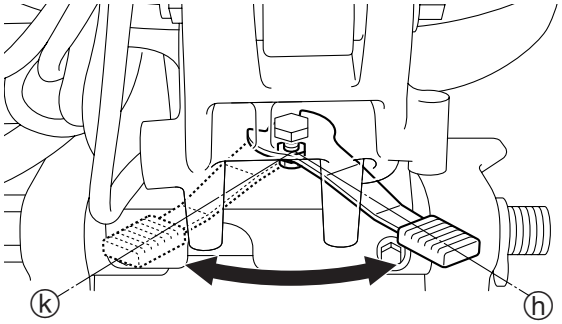


17. Install the rigging grommet ⑲ and grommet holder ⑳ into the bottom cowling.

18. Fasten the extension wiring harness ⑨, the battery cables ⑩, the alert indicator harness ⑮, the trolling switch harness ⑰, the shift cable, and the throttle cable with the plastic tie ㉑.



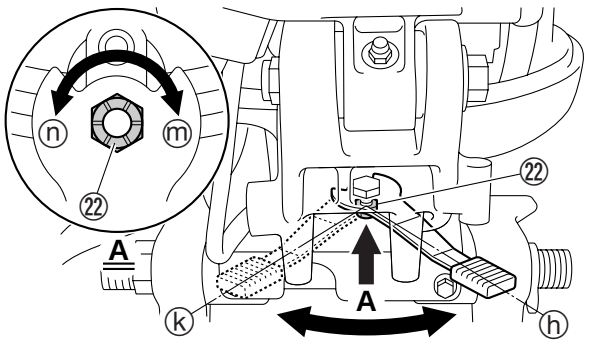
19. Check the steering friction plate assembly.



ⓗ Increase the friction
ⓚ Decrease the friction

TIP:
Check that the hoses, the harness, the lead, and the cables do no interfere with the steering friction plate assembly.

20. Adjust the friction adjusting nut ㉒ until steering operation works properly. **WARNING! Do not overtighten the friction adjuster. If there is too much resistance, it could be difficult to steer, which could result in an accident.**



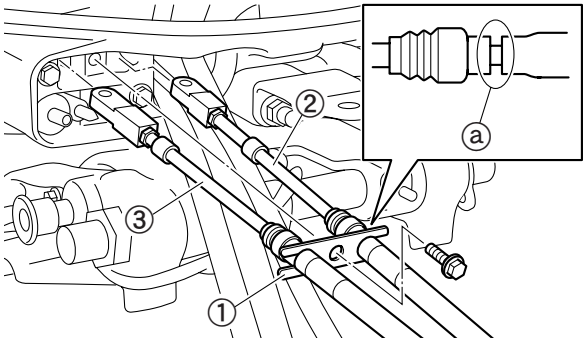
TIP:
- Tighten or loosen the friction adjusting nut at the steering lock lever in the position ⓗ.
- To increase the friction, tighten the friction adjusting nut ㉒ in direction ⓜ.
- To decrease the friction, loosen the friction adjusting nut ㉒ in direction ⓝ.

Installing the shift cable and throttle cable (remote control model)

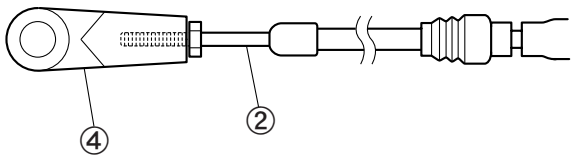
⚠ WARNING

Always perform the cable adjustment in advance, following the procedures in the remote control operation manual.

1. Install the cable guide ① to the grooves ⓐ of the shift cable ② and the throttle cable ③, and then install the bottom cowling.

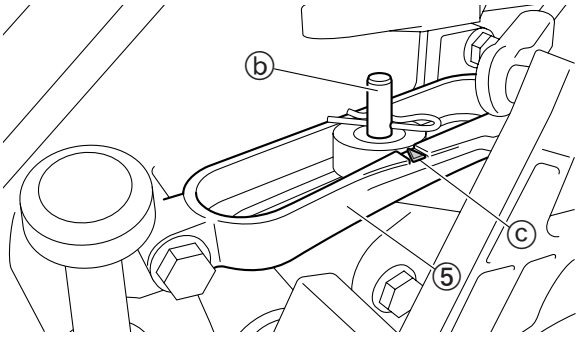


2. Fully screw in the shift cable joint ④ to the shift cable ②.



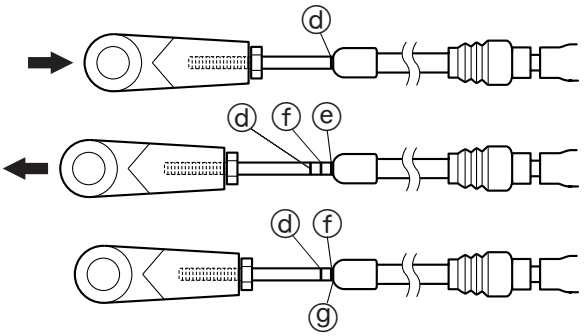
3. Set the remote control lever to the N position.

4. Align the pin ⓑ with the mark ⓒ on the shift bracket ⑤.

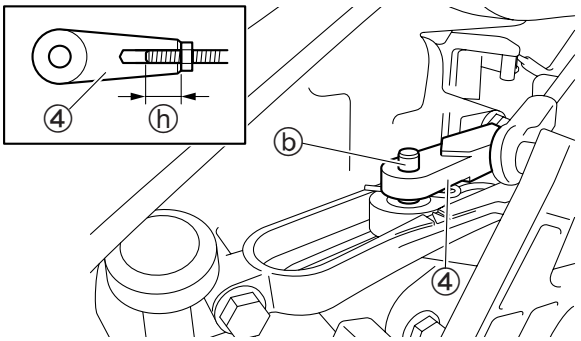


5. Make a mark ⓓ on the fully retracted inner cable, and then make a mark ⓔ on the fully extended inner cable.

6. Make a mark ⓕ in the middle point between marks ⓓ and ⓔ, and then align the mark ⓕ with the outer cable edge ⓖ.

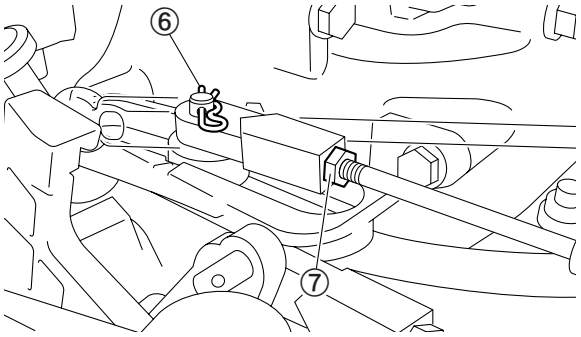


7. Adjust the shift cable joint ④, and then install the shift cable joint ④ to the pin ⓑ.
WARNING! The shift cable joint must be screwed in a minimum of 8.0 mm (0.31 in).



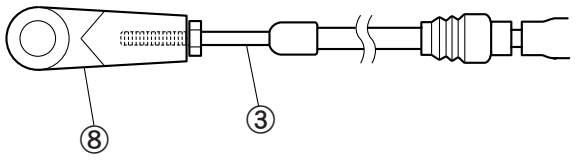
Dimension ⓗ: 8.0 mm (0.31 in) or more

8. Install the clip ⑥, and then tighten the shift cable locknut ⑦ to the specified torque.

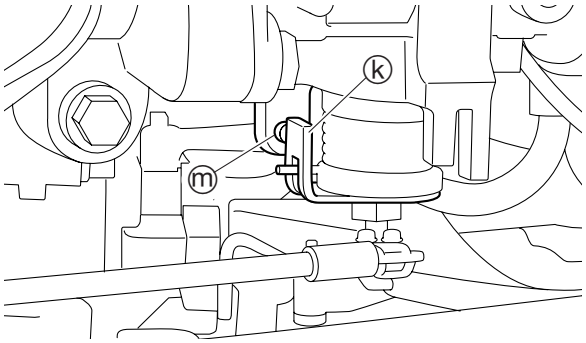


Shift cable locknut ⑦: 5 N·m (0.5 kgf·m, 3.7 ft·lb)

9. Fully screw in the throttle cable joint ⑧ to the throttle cable ③.

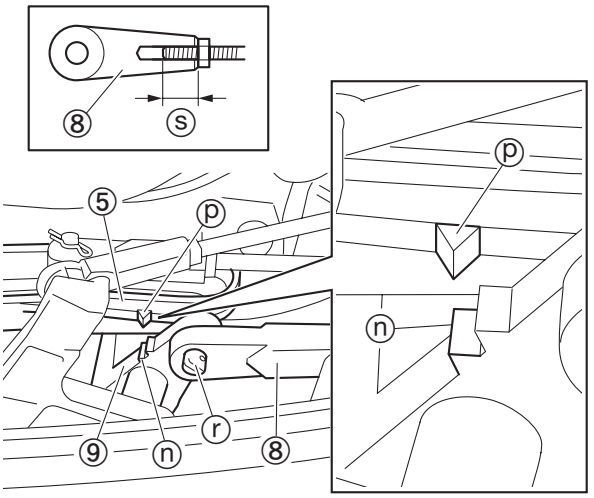


10. Check that the throttle control lever ⓚ contacts the stopper ⓜ.



11. Align the protrusion ⓝ on the throttle lever ⑨ with the protrusion ⓟ on the shift bracket ⑤.

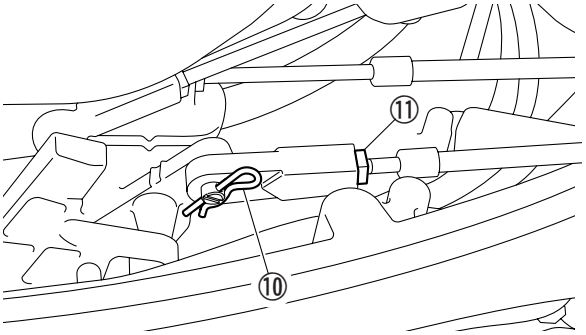
12. Adjust the throttle cable joint ⑧, and then install the throttle cable joint ⑧ to the pin ⓡ of the throttle lever ⑨. **WARNING! The throttle cable joint must be screwed in a minimum of 8.0 mm (0.31 in).**



Dimension ⓢ: 8.0 mm (0.31 in) or more

TIP:
Pull the inner cable to avoid free play (backlash).

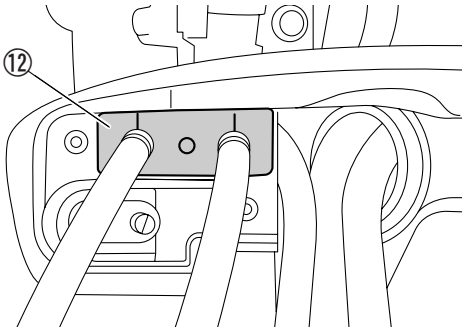
13. Install the clip ⑩, and then tighten the throttle cable locknut ⑪ to the specified torque.



Throttle cable locknut ⑪: 5 N·m (0.5 kgf·m, 3.7 ft·lb)

14. Check the shift cable and the throttle cable for proper operation.

15. Install the grommet ⑫.

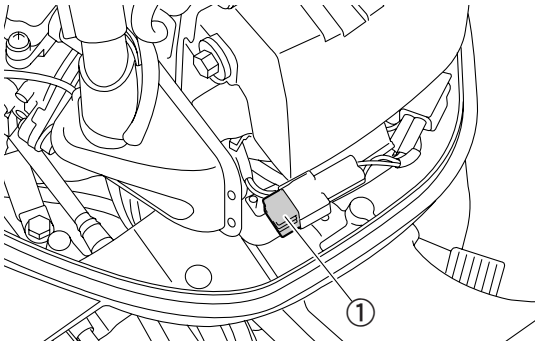


Installing the wiring harness (remote control model)

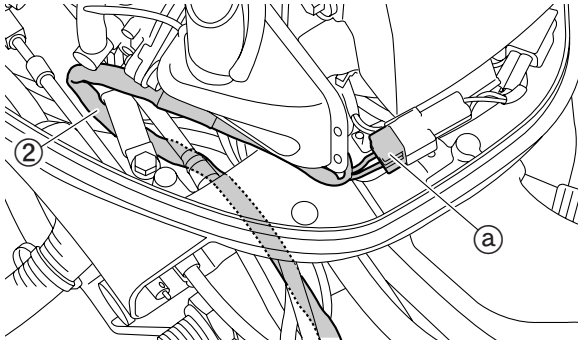
1. See “Installing the tiller handle” (3-11).

Installing the 6Y8 Multifunction Meter harness (remote control model)

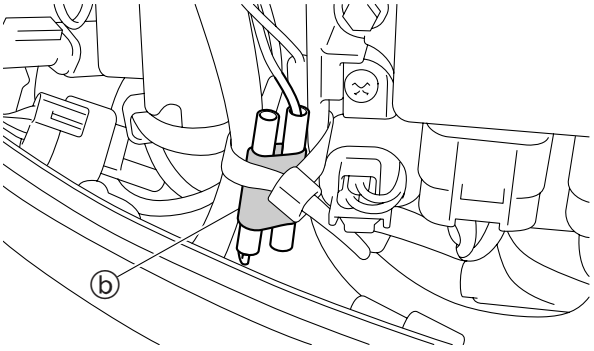
1. Remove the cap ①.



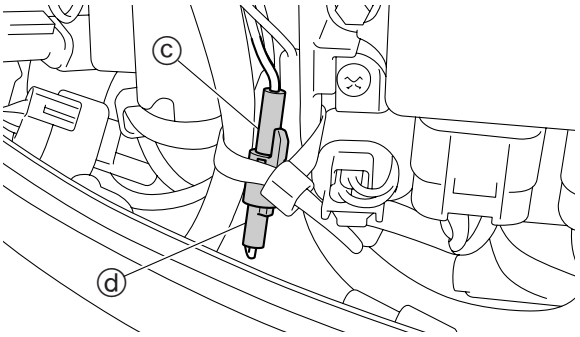
2. Run the 6Y8 Multifunction Meter harness ② into the bottom cowling, and then connect the 6Y8 Multifunction Meter harness coupler ⓐ.



3. Remove the yellow tape ⓑ.



4. Remove the each cap, and then connect the couplers ⓒ and ⓓ.



Installing the remote control box and tachometer (remote control model)

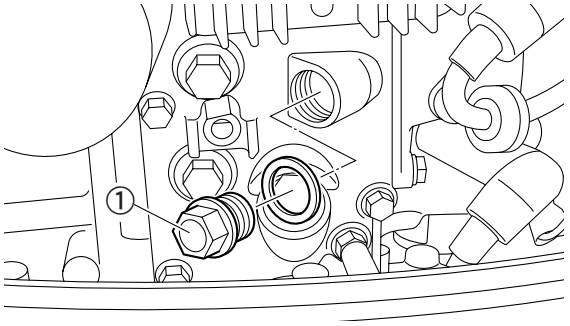
See “Remote control box operation manual” or “Rigging guide” for the installation procedures.

Optional equipment

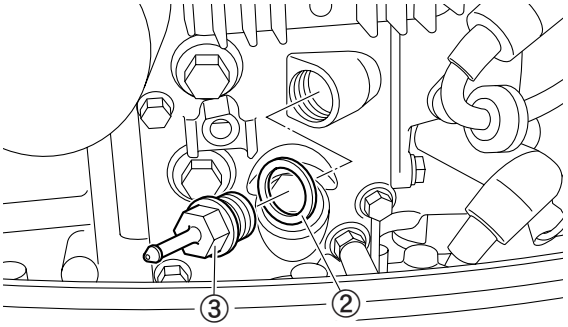
Installing the water pressure sensor

See “6Y8 Multifunction Meter set up manual” for details of the components.

1. Remove the plug ①.

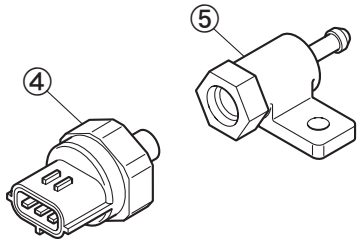


2. Install a new gasket ② and the nipple ③, and then tighten the nipple ③ to the specified torque.



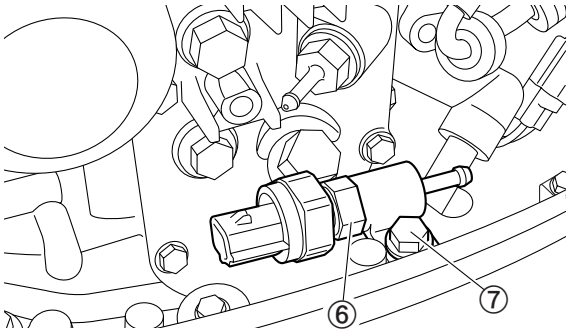
Nipple ③:
23 N·m (2.3 kgf·m, 17.0 ft·lb)

3. Install the water pressure sensor ④ to the water pressure sensor adapter ⑤, and then tighten the water pressure sensor ④ to the specified torque.

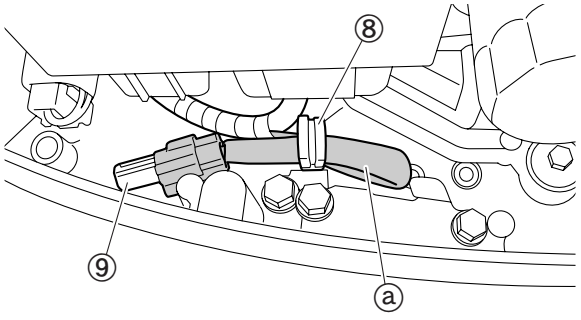


Water pressure sensor ④:
18 N·m (1.8 kgf·m, 13.3 ft·lb)

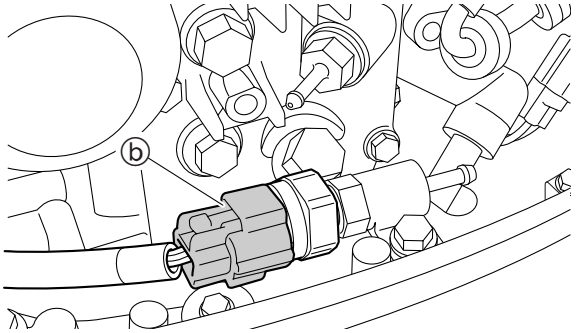
4. Install the water pressure sensor assembly ⑥ to the bottom cowling with a tapping screw ⑦.



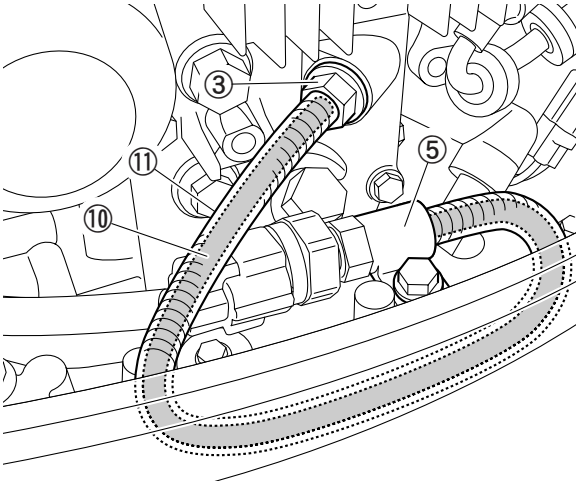
5. Remove the water pressure sensor harness ⓐ from the clamp ⑧, and then remove the cap ⑨.



6. Connect the water pressure sensor coupler ⓑ.



7. Install the extension hose ⑩ and corrugated tube ⑪ to the nipple ③ and the water pressure sensor adapter ⑤.

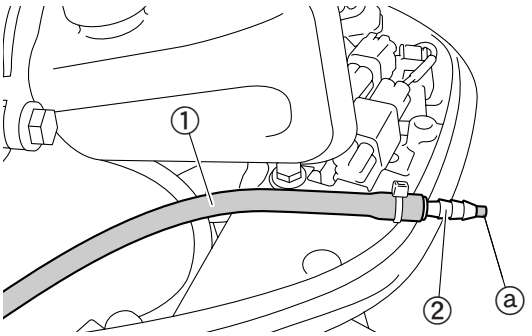


TIP:
Cut the extension hose ⑩ and corrugated tube ⑪ to 320.0 mm (12.6 in).

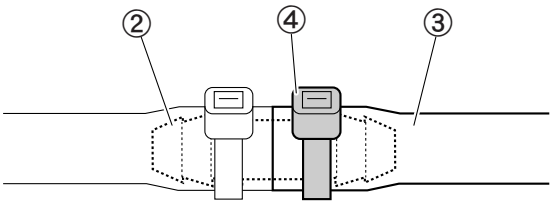
Installing the speed sensor

See “6Y8 Multifunction Meter set up manual” for details of the components.

1. Remove the speedometer hose ① from the rigging grommet, and then cut off the tip ⓐ of the nipple ②.

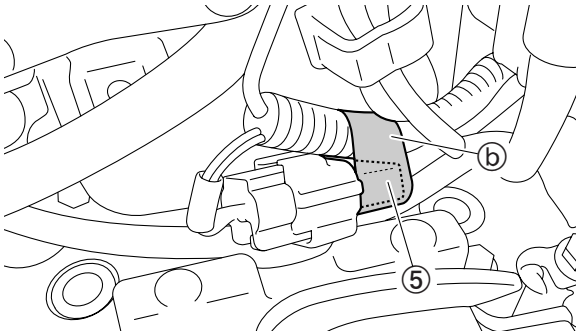


2. Install the extension hose ③ to the nipple ②, and then fasten it with a plastic tie ④.

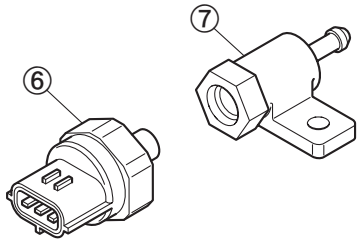


TIP:
Cut the extension hose ③ to 425.0 mm (16.7 in).

3. Remove the black tape ⓑ, and then remove the cap ⑤.

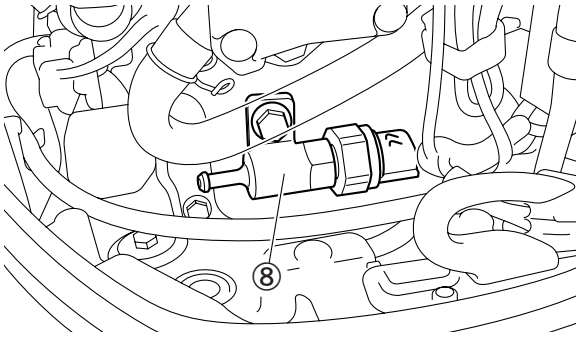


4. Install the speed sensor ⑥ to the speed sensor adapter ⑦, and then tighten the speed sensor ⑥ to the specified torque.

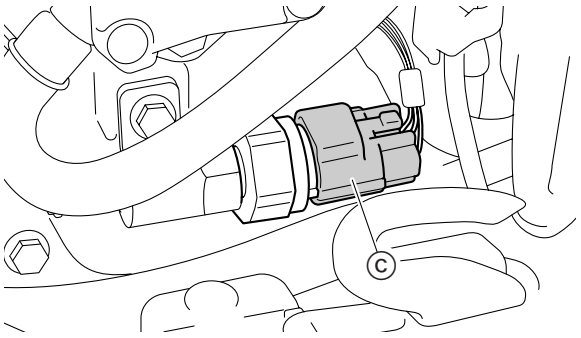


Speed sensor ⑥:
18 N·m (1.8 kgf·m, 13.3 ft·lb)

5. Install the speed sensor assembly ⑧ to the cylinder head cover.

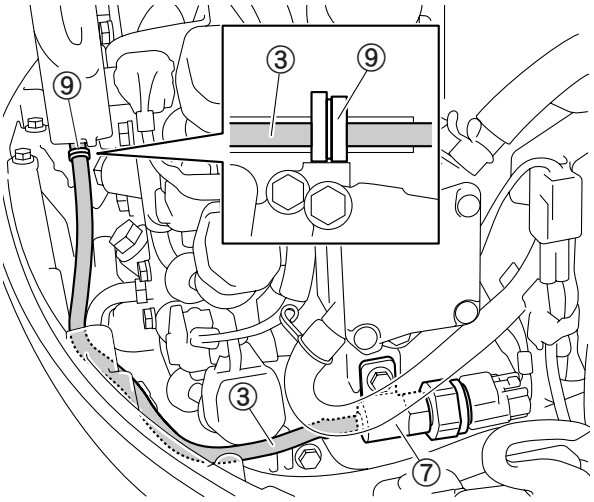


6. Connect the speed sensor coupler ⓒ.

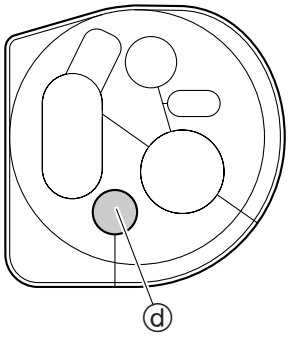


7. Run the extension hose ③ from the port side.

8. Connect the extension hose ③ to the speed sensor adapter ⑦, and then install the extension hose ③ to the clamp ⑨.



9. Install the rubber seal in the area ⓓ.



TIP:
Cut the rubber seal to 30.0 mm (1.2 in).

Installing the battery

⚠ WARNING

Improper battery connections or cable size selection may result in a fire.

NOTICE

If battery connections are reversed, thorough electrical system testing is required. Replace damaged components.

System diagram

Outboard motor application

(*1) Install the water-proof cap to the open terminal.

① Remote control box
② Switch panel
③ Extension wiring harness
④ Engine ECM
⑤ Pigtail bus wire
⑥ Single hub
⑦ Main bus wire
⑧ 8ft power wire
⑨ Fuse (10A)
⑩ Tachometer unit
⑪ Speedometer unit
⑫ Receiver
⑬ Power lead
⑭ In-line resister

ⓐ Power port
ⓑ Bus port
ⓒ Device port

Color code
B : Black
G : Green
R : Red
Y : Yellow

Rigging recommendations

Battery requirement

Select the stud of battery which is best-suited to the terminal size.
Solder the connection of terminals and cables to prevent them from corroding.

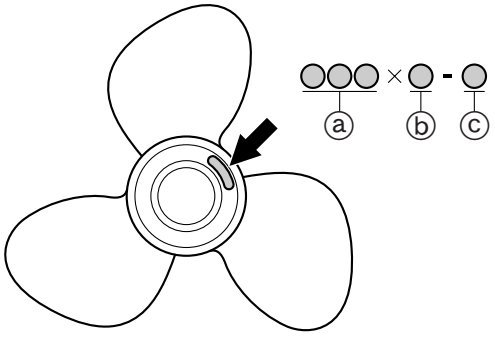
Ambient temperature above 0 °C (32 °F)	
Unit	Minimum capacity
CCA/EN	430.0 Amps
20HR/IEC	70.0 Ah

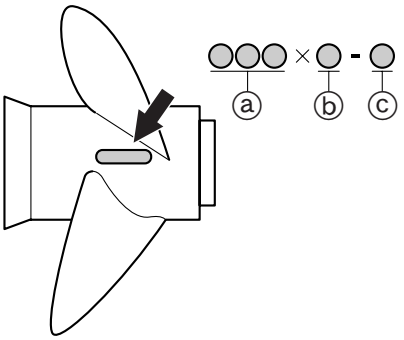
Propeller selection

The performance of a boat and outboard motor will be critically affected by the size and type of the propeller you choose. Propellers greatly affect boat speed, acceleration, engine life, fuel economy, and even boating and steering capabilities. An incorrect choice could adversely affect performance and could also seriously damage the engine.
Use the following information as a guide to select the propeller that meets the operating conditions of the boat and the outboard motor.

Propeller size

The size of the propeller is indicated on the propeller boss end and on the side of the propeller boss.





ⓐ Propeller diameter (in inches)
ⓑ Propeller pitch (in inches)
ⓒ Propeller type (propeller mark)

Selection

When the engine speed is at full throttle operating range, the ideal propeller for the boat is the one that provides maximum performance in relation to the boat speed and fuel consumption.

Full throttle operating range: 5000–6000 r/min

Propeller size (in)	Material
10 × 15 - G	Aluminum
11 × 15 - G	
11 3/8 × 12 - G	
11 1/8 × 13 - G	
11 5/8 × 11 - G	
10 3/4 × 17 - G	
10 3/4 × 16 - G	
12 1/4 × 9 - G	
10 3/8 × 13 - G	
10 5/8 × 12 - G	
10 1/4 × 14 - G	
11 1/4 × 14 - G	
10 5/8 × 13 - G	
12 × 11 - G	Stainless
11 3/4 × 12 - G	
11 3/8 × 12 - G	
11 1/2 × 13 - G	
11 1/4 × 14 - G	
10 1/4 × 15 - G	
10 1/4 × 16 - G	

Troubleshooting

YDIS 4-1
Feature 4-1
Hardware requirement 4-1
Function 4-2
YDIS kit 4-3
Connecting the communication cable to the outboard motor 4-3

Troubleshooting the power unit 4-4
Troubleshooting procedure 4-4
Troubleshooting the power unit using the YDIS 4-4
Trouble code and checking step 4-6
Troubleshooting the power unit using the diagnostic flash indicator 4-8
Troubleshooting the power unit (trouble code not detected) 4-9
Troubleshooting the PTT unit 4-12
Troubleshooting the lower unit 4-13

YDIS

This manual contains model-specific information. See “YDIS Instruction Manual” for detailed information.

Feature

The newly developed YDIS provides quicker detection and analysis of engine malfunctions.
By connecting your computer to the engine ECM of an outboard motor using the communication cable, this software can be used to display sensor data and data stored in the engine ECM on the computer’s monitor.
If this software is run on Microsoft Windows 2000, Windows XP, or Windows Vista, the information can be displayed in colorful graphics. Moreover, the software can be operated using either a mouse or a keyboard.
In addition, the data for the main functions (Diagnosis, Diagnosis record, Engine monitor, Data logger, and Record of engine oil exchange) can be saved on a disk or printed out.

Hardware requirement

Make sure that your computer meets the following requirements before using this software.

Computer:	IBM PC/AT compatible computer
Operating system:	Microsoft Windows 2000, Windows XP, or Windows Vista
CPU:	
Windows 2000:	Pentium, 166 MHz or higher (Pentium 233 MHz or higher recommended)
Windows XP:	Pentium, 300 MHz or higher (Pentium 500 MHz or higher recommended)
Windows Vista:	Core family, 1.6 GHz or higher (Core family 2.0 GHz or higher recommended)
Memory:	
Windows 2000:	64 MB or more (128 MB or more recommended)
Windows XP:	128 MB or more (256 MB or more recommended)
Windows Vista:	1 GB or more
Hard disk free space:	20 MB or more (40 MB or more recommended)
Drive:	CD-ROM drive
Display:	VGA (640 × 480 pixels) 256 or more colors SVGA (800 × 600 pixels or more recommended) 256 or more colors
Mouse:	Compatible with the operating systems mentioned above
Communication port:	RS232C (Dsub-9 pin) port, USB port
Printer:	Compatible with the operating systems mentioned above

TIP:

- The amount of memory and the amount of free space on the hard disk differs depending on the computer.
- Using this software while there is not enough free space on the hard disk could cause errors and result in insufficient memory.
- This software will not run properly on some computers.
- When starting up this program, do not start other software applications.
- Do not use the screen saver function or the energy saving feature when using this program.
- If the engine ECM is changed, restart the program.
- Windows XP and Windows Vista are multiuser operating system, therefore, make sure to end this program if the login user is changed.

Function

- **Diagnosis**

  Displays each part name, and the engine ECM trouble codes and status when the engine start switch is turned to “ON.” This allows you to quickly specify the malfunctioning parts. The trouble codes displayed are the same as those described in this chapter. See “Trouble code and checking step” (4-6).

- **Diagnosis record**

  Displays each part name and the engine ECM trouble codes that have been registered. This allows you to check the outboard motor’s record of malfunctions. The trouble codes displayed are the same as those described in this chapter. See “Trouble code and checking step” (4-6).

- **Engine monitor**

  Each sensor status and the engine ECM data are displayed while the engine start switch is at “ON.” This enables you to find the malfunctioning parts quickly. In addition, the data displayed using the Engine monitor function can be displayed in a graph.

Engine speed	TPS voltage	Intake temperature
Intake pressure (*1)	Throttle valve opening	Engine stop lanyard switch (*2)
Atmospheric pressure	ISC valve opening	Shift position switch (*3)
Ignition timing	Fuel injection duration	Oil press switch
Battery voltage	Water temperature	—

(*1) Intake air pressure
(*2) Engine shut-off switch
(*3) Neutral switch

- **Stationary test**

  Operation tests can be performed with the engine off.

Ignite ignition coils (#1–#3)	Operate injector (#1–#3)	Operate ISC valve
Operate electric fuel pump	—	—

- **Active test**

  The tests can be carried out while the engine is running and the shift is in the N position. It is not possible to carry out the test while the boat is running.

Fully open ISC valve	Angle of ISC valve opening

- **Data logger**

  Displays 13 minutes of recorded data for 2 or more of the items stored in the engine ECM. In addition, the operating time as compared to the engine speed and the total operating time are displayed. This allows you to check the operating status of the engine. You can also save the engine ECM record data on a file so that you can view and display the graph later.

Engine speed	TPS voltage	Intake pressure
Battery voltage	Water temperature	Oil press switch

- **Record of engine oil exchange**

  This function can record the history of engine oil exchanges.

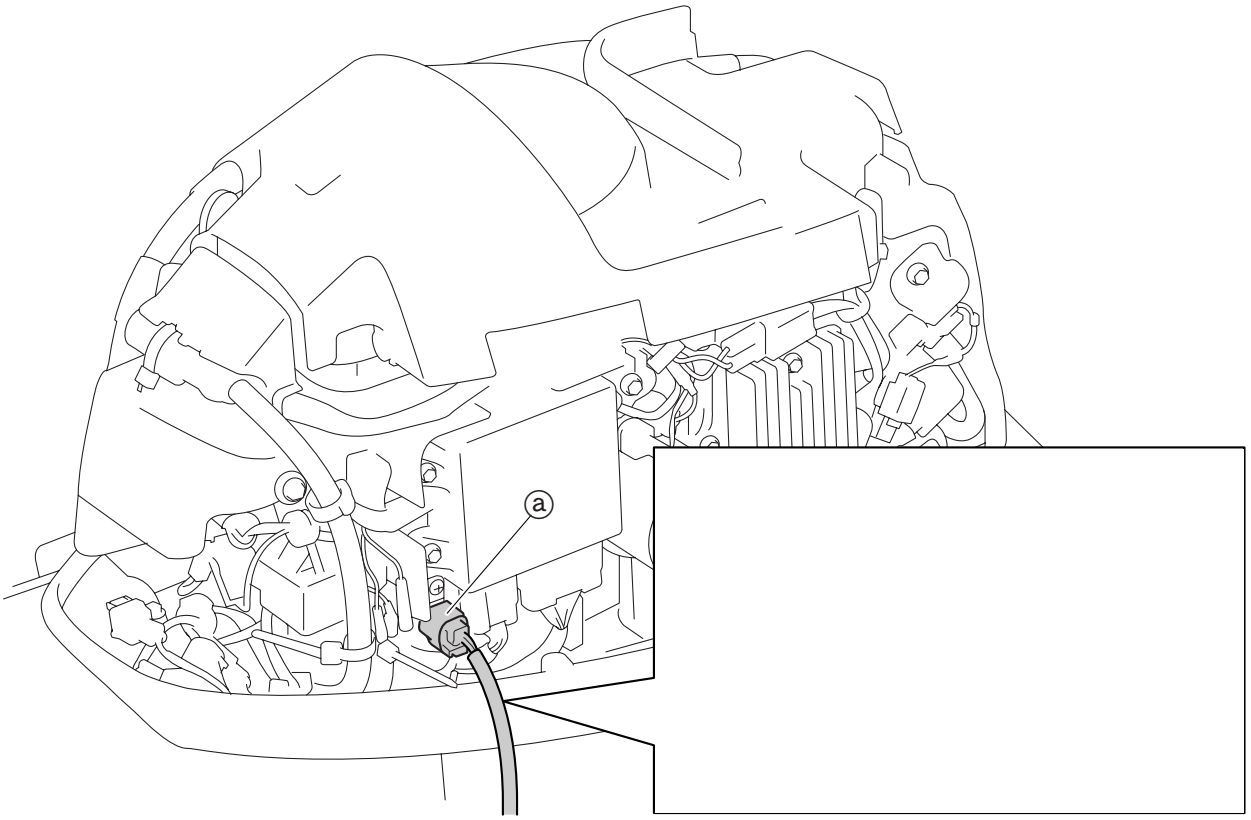
YDIS kit

No.	Item	Q'ty
①	CD-ROM (software + instruction manual)	1
②	Adapter	1
③	Communication cable	1

① ② ③

YDIS (CD-ROM, Ver. 1.32) ①:
60V-WS853-05
YDIS (KIT) ①, ②, ③:
60V-85300-05

Connecting the communication cable to the outboard motor



ⓐ YDIS coupler (gray)
A

YDIS connecting harness ①:
90890-06882

Troubleshooting the power unit

Troubleshooting procedure

1. Before troubleshooting the outboard motor, make sure that fresh fuel of the specified type has been used.
2. Make sure that all electrical connections are secure and free from corrosion, and that the battery is fully charged.
3. Check the trouble code using the YDIS first, and then check the electronic control system following the trouble code chart.
4. When a trouble code is detected, check the data logger of the engine ECM record data graph as well.
5. If a trouble code is not detected, check as well the power unit according to “Troubleshooting the power unit (trouble code not detected)” (4-9).
6. Before using the YDIS to check the power unit, check the engine ECM circuit. See “Checking the engine ECM circuit” (5-16).

TIP:

- When deleting the diagnosis record on the YDIS, make sure to check the time that the trouble codes were detected.
- When checking the input voltage of a part, the coupler or connector must be disconnected. As a result, the engine ECM determines that the part is disconnected and a trouble code is detected. Therefore, make sure to delete the diagnosis record after checking the input voltage.

Troubleshooting the power unit using the YDIS

1. Use the trouble codes displayed by the YDIS to check each part according to the “Trouble code and checking step” table.
2. Delete the trouble codes after checking, repairing, or replacing a part and check that the trouble codes are not detected again. If the same trouble codes are detected, the engine ECM may be faulty.
3. Check the items listed in the table. If all the items are in good condition, delete the trouble code, and then check the trouble codes again. If the same trouble codes are detected again, the engine ECM is faulty.

Trouble code table

○: Indicate
—: Not applicable

Trouble code	Item	Diagnostic flash indicator	YDIS diagnosis	YDIS diagnosis record
1	No trouble (Functioning properly)	○	—	—
15	Water temp sensor malfunction (Thermo sensor malfunction)	○	○	○
18	Throttle position sensor malfunction	○	○	○
19	Battery voltage malfunction (Charging system malfunction)	○	○	○
23	Intake temp sensor malfunction (Air temperature sensor malfunction)	○	○	○
27	Water in fuel	○	○	—
28	Shift position switch malfunction (Neutral switch “OFF”)	○	○	○

Trouble code	Item	Diagnostic flash indicator	YDIS diagnosis	YDIS diagnosis record
29	Intake press sensor malfunction (Air pressure sensor malfunction)	○	○	○
37	Intake air passage (Air leakage)	○	○	○
44	Engine stop lanyard switch “ON” (Engine shut-off switch “ON”)	○	○	—
49	Over cooling	○	○	○
		○	—	○

Trouble code and checking step

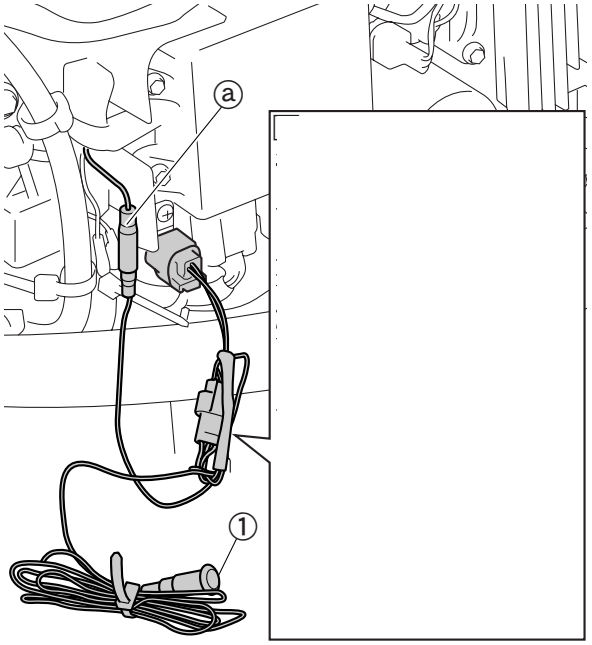
—: Not applicable

Trouble code	Item	Condition	LAN gauge display	Symptom	Remarks	Checking steps	Refer to page
15	Water temp sensor malfunction	Out of specification	C/E	High idle speed Degraded acceleration performance Declining maximum engine speed Overheat	—	Measure the thermo sensor input voltage.	5-29
						Measure the thermo sensor resistance.	5-29
						Check for wiring continuity between the thermo sensor and the engine ECM.	5-29 A-3
18	Throttle position sensor malfunction	Out of specification	C/E	High idle speed Degraded acceleration performance	—	Measure the TPS output voltage and opening angle using the YDIS.	5-18
						Measure the throttle body input voltage.	5-17
						Check for wiring continuity between the throttle body and the engine ECM.	5-17 A-3
19	Battery voltage malfunction	Below specified voltage	C/E	Engine does not restart (Depends on battery conditions) Engine operates normally	—	Measure the lighting coil output peak voltage.	5-24
						Measure the Rectifier Regulator output peak voltage.	5-25
						Check the Rectifier Regulator for continuity.	5-25
23	Intake temp sensor malfunction	Out of specification	C/E	Engine operates normally High idle speed	—	Check the air temperature using the YDIS.	5-28
						Measure the throttle body input voltage.	5-17
						Check for wiring continuity between the throttle body and the engine ECM.	5-17

Trouble code	Item	Condition	LAN gauge display	Symptom	Remarks	Checking steps	Refer to page
27	Water in fuel	Water in fuel	W/F	Alert buzzer comes on when engine start switch is turned to “ON” Alert buzzer stops when engine started	—	Check for water in fuel filter.	6-7
						Measure the water detection switch input voltage.	5-20
						Check the water detection switch for continuity.	5-20
						Check for wiring continuity between the water detection switch and the engine ECM.	5-20 A-3
28	Shift position switch malfunction	Irregular signal	C/E	Engine operates normally	—	Check the gear shift operation.	10-5
						Measure the neutral switch input voltage.	5-29
						Check the neutral switch continuity.	5-29
						Check for wiring continuity between the neutral switch and the engine ECM.	5-29 A-3
29	Intake press sensor malfunction	Out of specification	C/E	High idle speed	—	Check the air pressure using the YDIS.	5-28
						Measure the throttle body input voltage.	5-17
						Check for wiring continuity between the throttle body and the engine ECM.	5-17 A-3
37	Intake air passage malfunction	Air leak	C/E	High idle speed Engine operates normally, except at idle.	—	Check the gaskets of the intake manifold and the throttle body.	6-17
						Check the intake manifold for cracks.	6-19
						Check the opening condition of TPS and the ISC valve using the YDIS.	5-18 5-18
49	Over cooling	Irregular signal	C/E	Engine operates normally	—	Check that the trouble code 15 has not appeared.	4-6
						Check the thermostat.	7-49
86	Immobilizer	Communication error	C/E	Declining maximum engine speed	—	Check that the immobilizer is properly connected.	2-13

Troubleshooting the power unit using the diagnostic flash indicator

1. Connect the special service tool ①.



ⓐ Diagnostic test lead (Blue/White)

Diagnostic flash indicator B ①: 90890-06865 YDIS connecting harness ②: 90890-06882

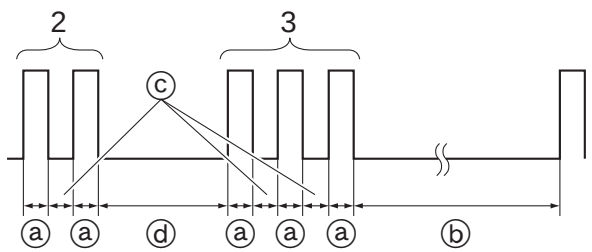
TIP:

When performing this diagnosis, all the electrical wires must be properly connected.

2. Start the engine and let it idle.

3. Check the flash patterns that indicate a trouble code.

Example: the flash pattern below is for the trouble code 23.



ⓐ Light on, 0.33 second
ⓑ Light off, 4.95 seconds
ⓒ Light off, 0.33 second
ⓓ Light off, 1.65 seconds

4. If a trouble code is detected, see “Trouble code and checking step” (4-6).

TIP:

When more than one trouble code is detected, the diagnostic flash indicator B flashes in the pattern of the lowest trouble code. After that trouble code is corrected, the indicator flashes in the pattern of the next lowest trouble code. This continues until all the trouble codes are detected and corrected.

Troubleshooting the power unit (trouble code not detected)

Troubleshooting when trouble codes are not available consists of the following 3 items.
Symptom 1: Specific trouble conditions
Symptom 2: Trouble conditions of an area or individual part
Cause: The content considered as the trouble factors for symptom 2
— : Not applicable

Symptom 1: Engine does not crank.

Symptom 2	Cause	Checking step	Refer to page
Starter motor does not operate	Gear shift not in the N position	Set the gear shift to the N position.	10-5
	Blown fuse	Check the fuse.	5-1 A-5
	Starter relay malfunction	Check the starter relay.	5-30
	Engine start switch malfunction	Check the engine start switch.	5-31
	Neutral switch malfunction	Check the neutral switch.	5-32
	Short, open, or loose connection in the starter motor circuit	Check the starter relay input voltage.	5-30 A-5
		Check the wiring harness for continuity.	A-5
	Starter motor malfunction	Disassemble and check the starter motor.	5-36
Starter motor operates, but the engine does not crank	Starter motor malfunction	Check the starter motor pinion.	5-35
		Check the magnet switch.	5-35
	Stuck piston or crankshaft	Disassemble and check the power unit.	7-30 7-52
	Stuck drive shaft	Check the drive shaft bushing.	9-28
		Disassemble and check the lower unit.	8-11

Symptom 1: Engine will not start (engine cranks).

Symptom 2	Cause	Checking step	Refer to page
Engine ECM does not operate	Blown fuse	Check the fuse.	5-1
	Main relay malfunction	Check the main relay.	5-15
	Short, open, or loose connection in engine ECM circuit	Check for wiring continuity between the main relay and the engine ECM.	5-16 A-3
		Check for wiring continuity between the engine ECM and ground.	5-16 A-3
Spark plug does not spark (all cylinders)	Pulser coil malfunction	Measure the pulser coil output peak voltage.	5-27
		Check the pulser coil air gap.	7-1
		Measure the pulser coil resistance.	5-27
	Short, open, or loose connection in pulser coil circuit	Check for wiring continuity between the pulser coil and the engine ECM.	5-27
	Engine ECM malfunction	Check the engine ECM output peak voltage.	5-26

Symptom 2	Cause	Checking step	Refer to page
Fuel not supplied (all cylinders)	—	Check the fuel pressure.	6-4
	Clogged filter	Check the fuel filter for clog and dirt.	6-10
	Fuel leakage	Check the fuel line for leakage.	6-1
	High-pressure fuel pump malfunction	Check the high-pressure fuel pump operation using the YDIS.	5-22
		Check the high-pressure fuel pump resistance.	5-22
	Main relay malfunction	Check the main relay.	5-15
	Short, open, or loose connection in high-pressure fuel pump circuit	Check the high-pressure fuel pump input voltage.	5-22
		Check for wiring continuity between the high-pressure fuel pump and the main relay.	5-22 A-3
		Check for wiring continuity between the high-pressure fuel pump and ground.	5-22 A-3
	Fuel pump malfunction	Check the fuel pump for leakage.	6-12
		Check the diaphragm for tear.	6-14
		Check the rocker arm.	7-41
Compression pressure is low	Improper valve timing	Check the timing belt.	7-15
	Compression leakage	Check the compression pressure.	7-1
		Check the valve for bend or stuck.	7-33
		Check the piston and piston ring for damage.	7-52
		Check the cylinder for damage.	7-52
—	Intake air passage malfunction	Check the ISC valve for stuck.	5-18
		Check the intake manifold and throttle body for air leakage.	6-17

Symptom 1: Unstable engine idle speed, poor acceleration, poor performance, or limited engine speed.

Symptom 2	Cause	Checking step	Refer to page
Throttle valve does not move properly	Throttle valve malfunction	Check the throttle valve for proper movement.	6-19
	Throttle link and the throttle cable are not installed correctly	Adjust the throttle link and the throttle cable.	3-14 6-23
Spark plug does not spark (some cylinders)	Spark plug malfunction	Check the ignition spark.	5-26
		Check the spark plugs.	7-42
	Short, open, or loose connection in ignition coil circuit	Check the spark plug cap resistance.	5-27
		Check for wiring continuity between the ignition coil and the engine ECM.	5-26
	Ignition coil malfunction	Check the ignition coil resistance.	5-27
	Engine ECM malfunction	Check the engine ECM output peak voltage.	5-26
Fuel pressure is low	High-pressure fuel line malfunction	Check the fuel pressure.	6-4
		Check the pressure regulator.	6-5
		Check the fuel filter for clog and dirt.	6-9
		Check the high-pressure fuel pump.	5-22

Symptom 2	Cause	Checking step	Refer to page
Fuel not supplied (some cylinders)	Fuel injector malfunction	Check the fuel injector operation using the YDIS.	5-21
		Check the fuel injector resistance.	5-21
	Short, open, or loose connection in fuel injector circuit	Check the fuel injector input voltage.	5-21
		Check for wiring continuity between the fuel injector and the main relay.	5-21 A-3
		Check for wiring continuity between the fuel injector and the engine ECM.	5-21 A-3
	Clogged fuel injector filter	Replace the fuel injector.	6-39
	Engine ECM malfunction	Replace the engine ECM.	7-19
Compression pressure is low	Improper valve timing	Check the timing belt.	7-15
	Compression leakage	Check the compression pressure.	7-1
		Check the valve clearance.	7-2
		Check the rocker arm for damage.	7-41
		Check the camshaft for damage.	7-41
		Check the valve and valve seat for wear.	7-37
		Check the piston and piston ring for damage.	7-52
		Check the cylinder for scratch.	7-54

Symptom 1: High engine idle speed.

Symptom 2	Cause	Checking step	Refer to page
—	Air leakage (throttle valve–cylinder head)	Check the gaskets of the intake manifold and the throttle body.	6-17
		Check the intake manifold for cracks.	6-19
	Throttle link and the throttle cable are not installed correctly	Adjust the throttle link and the throttle cable.	3-14 6-23
	ISC valve malfunction	Check the ISC valve operation using the YDIS.	5-18

Symptom 1: Limited engine speed.

Symptom 2	Cause	Checking step	Refer to page
Buzzer comes on, overheat alert indicator comes on	Clogged cooling water inlet	Check the pilot hole for cooling water discharge.	10-3
		Check the cooling water inlet.	10-8
	Water pump impeller malfunction	Check the impeller.	8-5
		Check the Woodruff key.	8-5
		Check the insert cartridge.	8-5
	Water leakage from water pump housing	Check the water pump housing.	8-5
		Check the outer plate cartridge.	8-5
	Clogged cooling water passage	Check the cooling water passage.	2-17
	Thermostat malfunction	Check the thermostat.	7-49

Symptom 2	Cause	Checking step	Refer to page
Buzzer comes on, oil pressure alert indicator comes on	Insufficient engine oil	Check the oil level.	10-9
		Check for engine oil leakage.	2-16
		Check the valve seal and the valve.	7-37
		Check the piston ring.	7-54
	Engine oil pressure decrease	Check the oil pressure.	7-1
		Check the oil pressure switch.	5-18
		Check the oil pump.	7-30
		Check the oil strainer.	9-33
		Check the oil passage (power unit and the oil pump).	2-16
		Replace the oil filter.	10-10
—			

Symptom 1: Discharged battery.

Symptom 2	Cause	Checking step	Refer to page
—	Battery performance decrease	Check the battery capacity and specific gravity.	10-3
	Short, open, or loose connection in charging circuit	Check the battery cable and terminals for proper connections.	—
		Check the charging circuit for wiring connection and damage.	A-5
	Lighting coil malfunction	Check the lighting coil output peak voltage.	5-24
		Check the lighting coil resistance.	5-24
	Rectifier Regulator malfunction	Check the Rectifier Regulator output peak voltage.	5-25

Troubleshooting the PTT unit

Troubleshooting when trouble codes are not available consists of the following 3 items.
Symptom 1: Specific trouble conditions
Symptom 2: Trouble conditions of an area or individual part
Cause: The content considered as the trouble factors for symptom 2
— : Not applicable

Symptom 1: PTT unit does not operate.

Symptom 2	Cause	Checking step	Refer to page
PTT relay does not operate	Blown fuse	Check the fuse.	5-1
	PTT switch malfunction	Check the PTT switch.	5-43 5-44
	PTT relay malfunction	Check the PTT relay.	5-42
	Short, open, or loose connection of the wiring harness	Check the PTT switch input voltage.	5-43 5-44
		Check the PTT relay input voltage.	5-42
		Check for wiring continuity between the PTT switch and the PTT relay.	5-43 5-44

Symptom 2	Cause	Checking step	Refer to page
PTT motor does not operate	PTT motor malfunction	Check the PTT motor.	9-50
	Short, open, or loose connection of the PTT motor lead	Check for wiring continuity between the PTT motor and the PTT relay terminal.	A-5
PTT fluid pressure does not increase	Manual valve opened	Check the manual valve.	9-61
	Insufficient PTT fluid	Add sufficient fluid.	10-13
	PTT fluid leakage	Check the PTT unit for leakage.	10-13
	Clogged fluid passage	Disassemble and check the PTT unit.	9-52 9-58
		Check the filter for clog and dirt.	9-56
		Check the valves for damage.	9-56
		Check the fluid passage for clog.	9-52
	Gear pump malfunction	Check the gear pump operation.	9-56

Symptom 1: PTT unit does not hold the outboard motor up.

Symptom 2	Cause	Checking step	Refer to page
PTT fluid pressure does not increase	Manual valve opened	Check the manual valve.	9-61
	Insufficient PTT fluid	Add sufficient fluid.	10-13
	PTT fluid leakage	Check the PTT unit for leakage.	10-13
	Clogged fluid passage	Disassemble and check the PTT unit.	9-52 9-58
		Check the valves for damage.	9-56
		Check the fluid passage for clog.	9-52

Troubleshooting the lower unit

Troubleshooting when trouble codes are not available consists of the following 3 items.
Symptom 1: Specific trouble conditions
Symptom 2: Trouble conditions of an area or individual part
Cause: The content considered as the trouble factors for symptom 2

— : Not applicable

Symptom 1: Shift mechanism of forward gear and reverse gear does not operate properly.

Symptom 2	Cause	Checking step	Refer to page
—	Shift cable malfunction	Adjust the shift cable.	3-14
	Shift rod malfunction	Check the shift rod for wear.	8-14
		Check the detent mechanism.	8-11
—	Shift mechanism malfunction (in lower unit)	Check the shift rod cam for proper position.	8-11
		Check the dog clutch.	8-8
		Check the forward gear, reverse gear and the pinion for damage and wear.	8-8 8-14
		Adjust the shims.	8-22

— MEMO —

Electrical system

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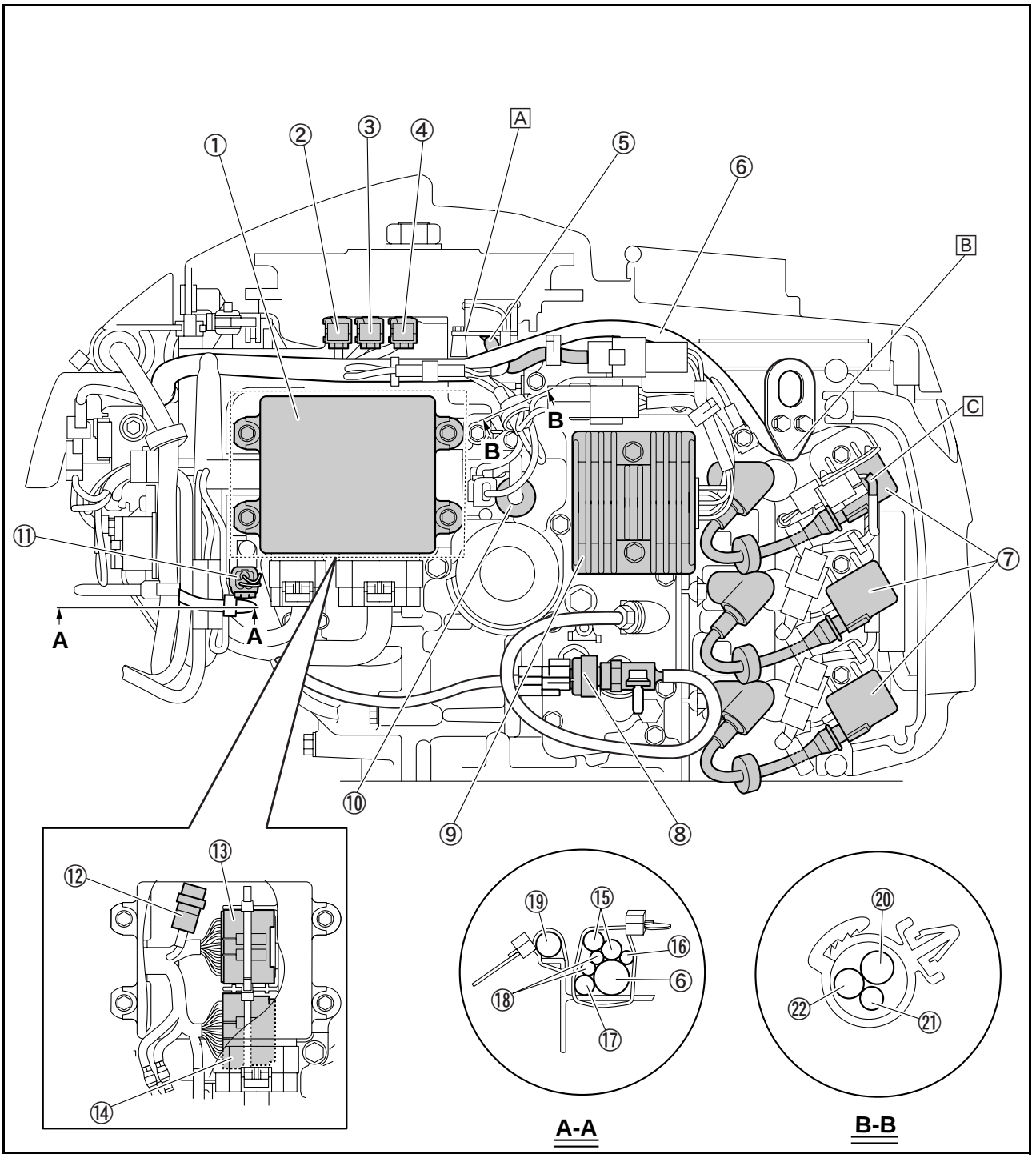
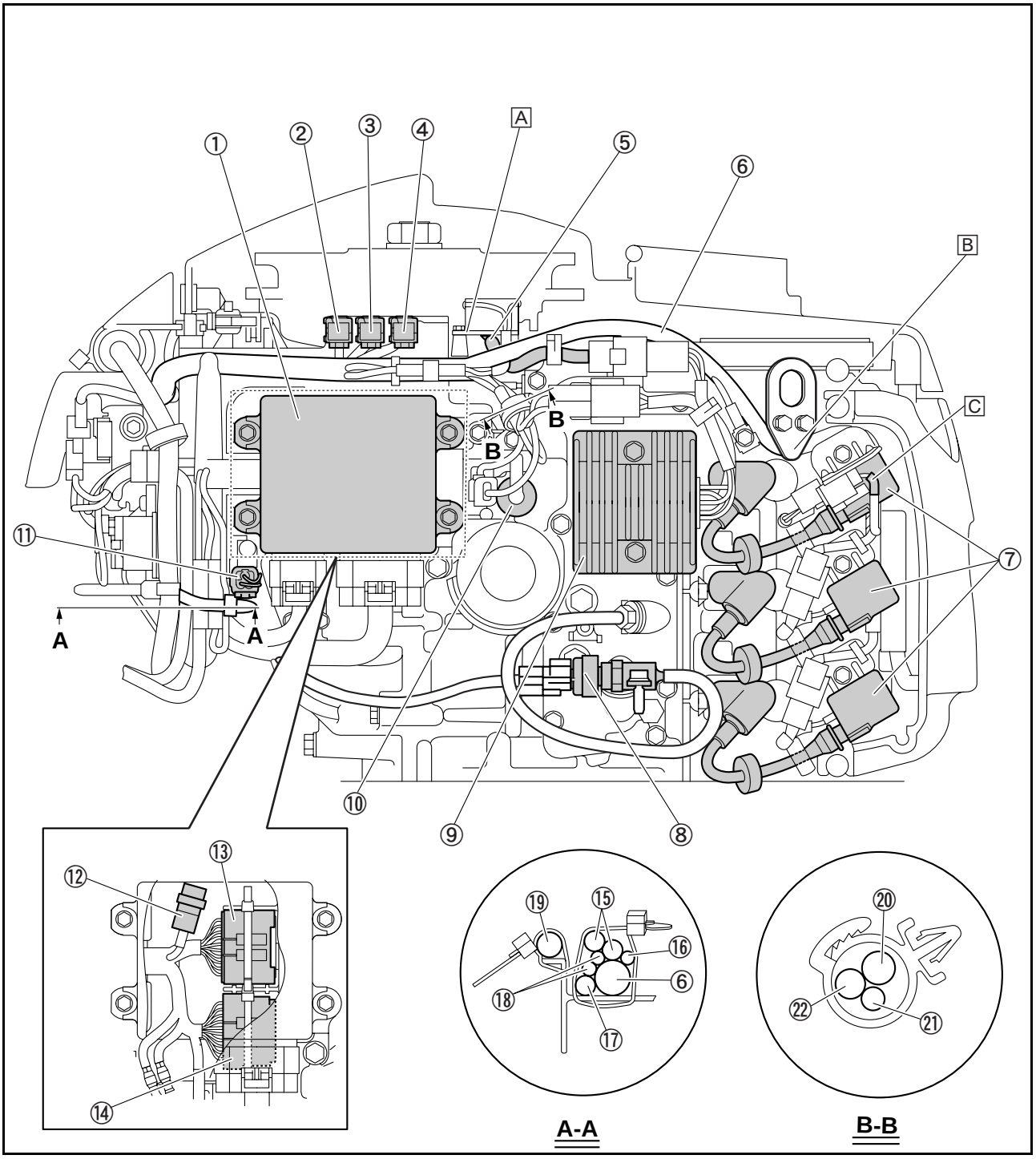
Electrical component and wiring harness routing

Port view



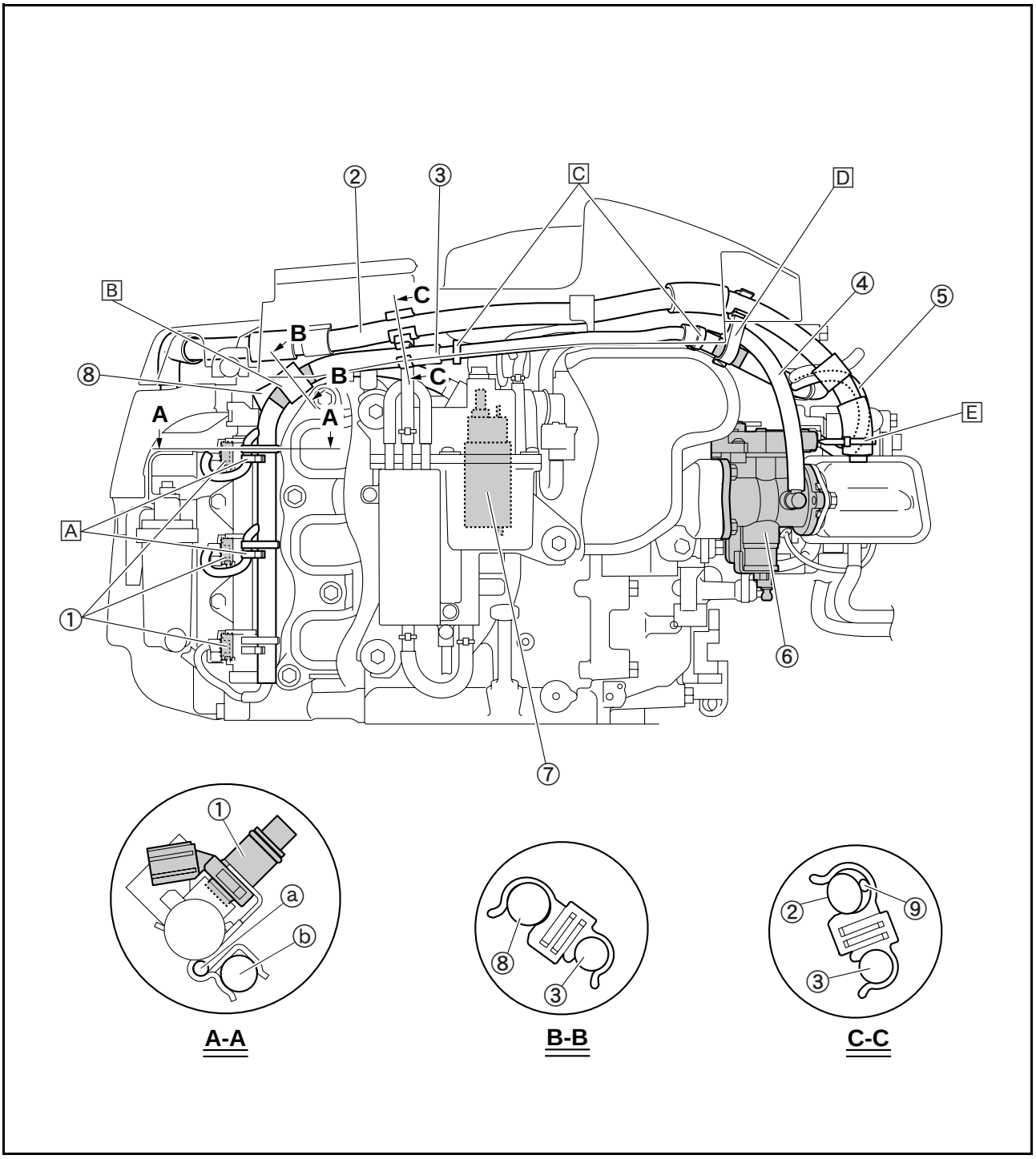
① Engine ECM
② Fuse (20 A) (engine start switch, PTT switch)
③ Fuse (30 A) (main relay)
④ Fuse (20 A) (starter relay)
⑤ Lighting coil lead
⑥ Wiring harness
⑦ Ignition coil
⑧ Water pressure sensor (option)
⑨ Rectifier Regulator
⑩ Oil pressure switch
⑪ YDIS coupler
⑫ Diode (connect to the PTT relay)
⑬ Joint connector 2
⑭ Joint connector 1
⑮ Trim sensor lead
⑯ Flash indicator connector



⑰ PTT motor lead
⑱ Starter relay lead
⑲ Extension wiring harness
⑳ Rectifier Regulator lead
㉑ Thermo sensor lead
㉒ Oil pressure connector

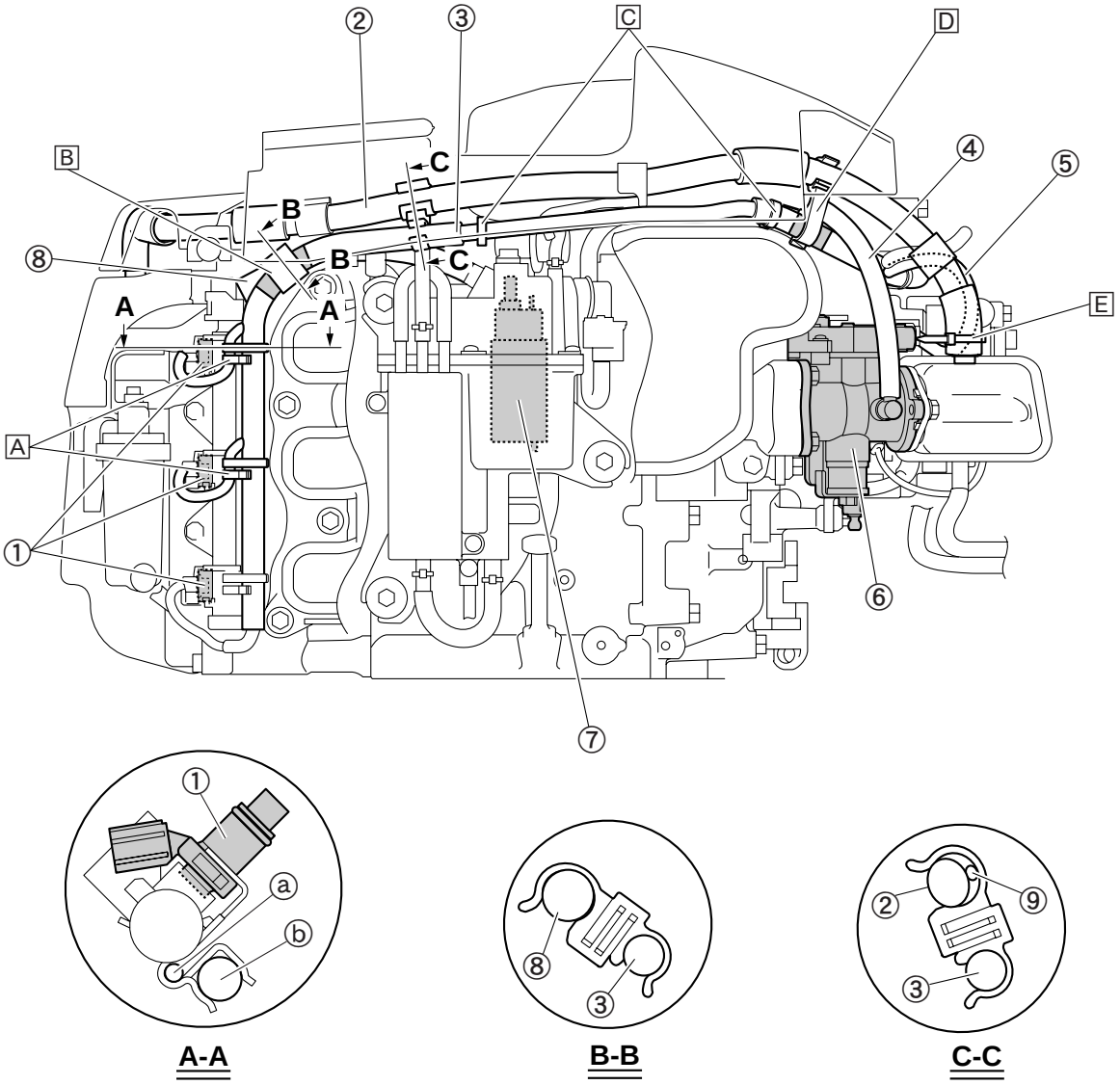
A Pass the lighting coil lead ⑤ through the groove of the magnet base.
B Pass the wiring harness ⑥ between the engine hanger and the cylinder head.
C Connect the ignition coil coupler marked with white tape to the #1 cylinder ignition coil.

Starboard view



① Fuel injector
② Blowby hose
③ Wiring harness
④ Vapor gas hose
⑤ Throttle body lead
⑥ Throttle body
⑦ High-pressure fuel pump
⑧ Fuel hose
⑨ Vapor shut-off valve lead

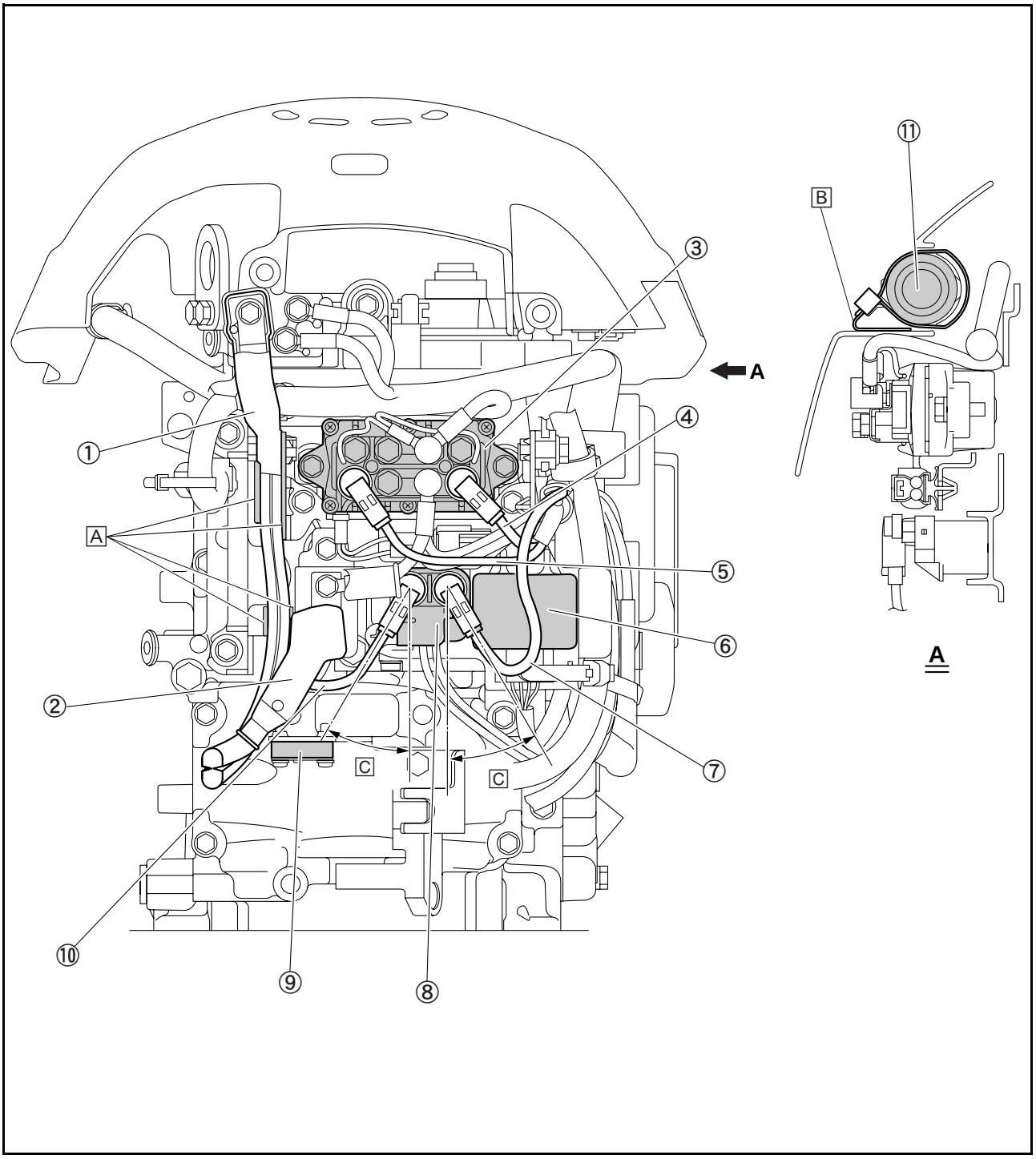
[A] Install the injector leads #1 and #2 into the positions ⓐ, and then install the wiring harness into the positions ⓑ.
[B] Clamp the fuel hose ⑧ and the wiring harness ③ at the position marked with white tape.
[C] Install the wiring harness holders to the holes of the intake manifold.



D Clamp the holder to the wiring harness ③ at the position marked with white tape, and then install the vapor gas hose ④ and the blowby hose ② to the holder.

E Fasten the throttle body leads ⑤ to the blowby hose ② with a plastic tie.

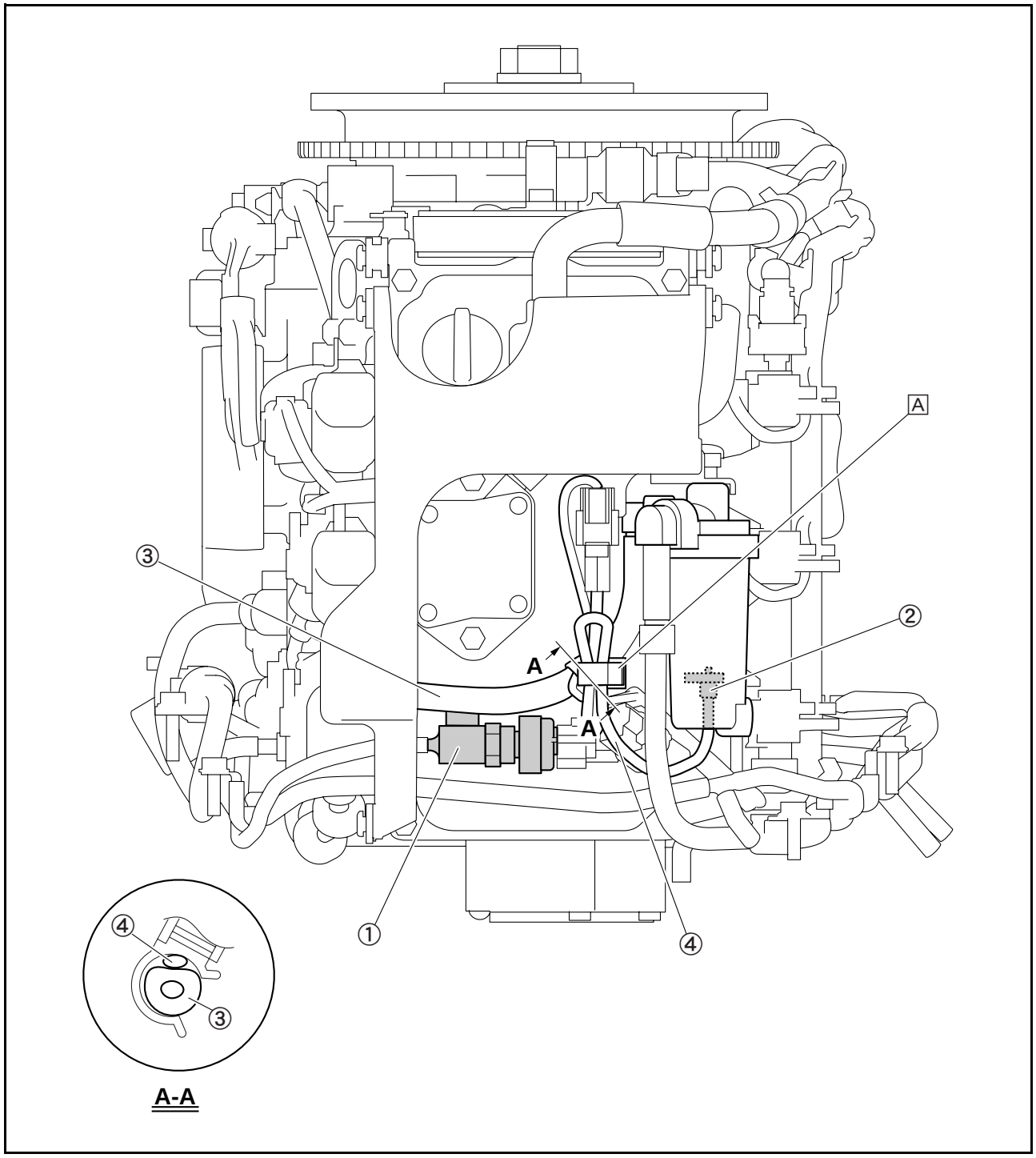
Front view



① Negative battery cable
② Positive battery cable
③ PTT relay
④ PTT motor lead (blue)
⑤ PTT motor lead (green)
⑥ Main relay
⑦ Starter relay lead (red)
⑧ Starter relay
⑨ Neutral switch
⑩ Starter relay lead (brown)
⑪ 10-pin coupler

A Install the negative battery cable ① into the slots of the bracket.
B After fastening the 10-pin coupler ⑪, fold the end of plastic tie inward so that it does not come out.
C The PTT motor leads ⑦ and ⑩ must be installed within 30°.

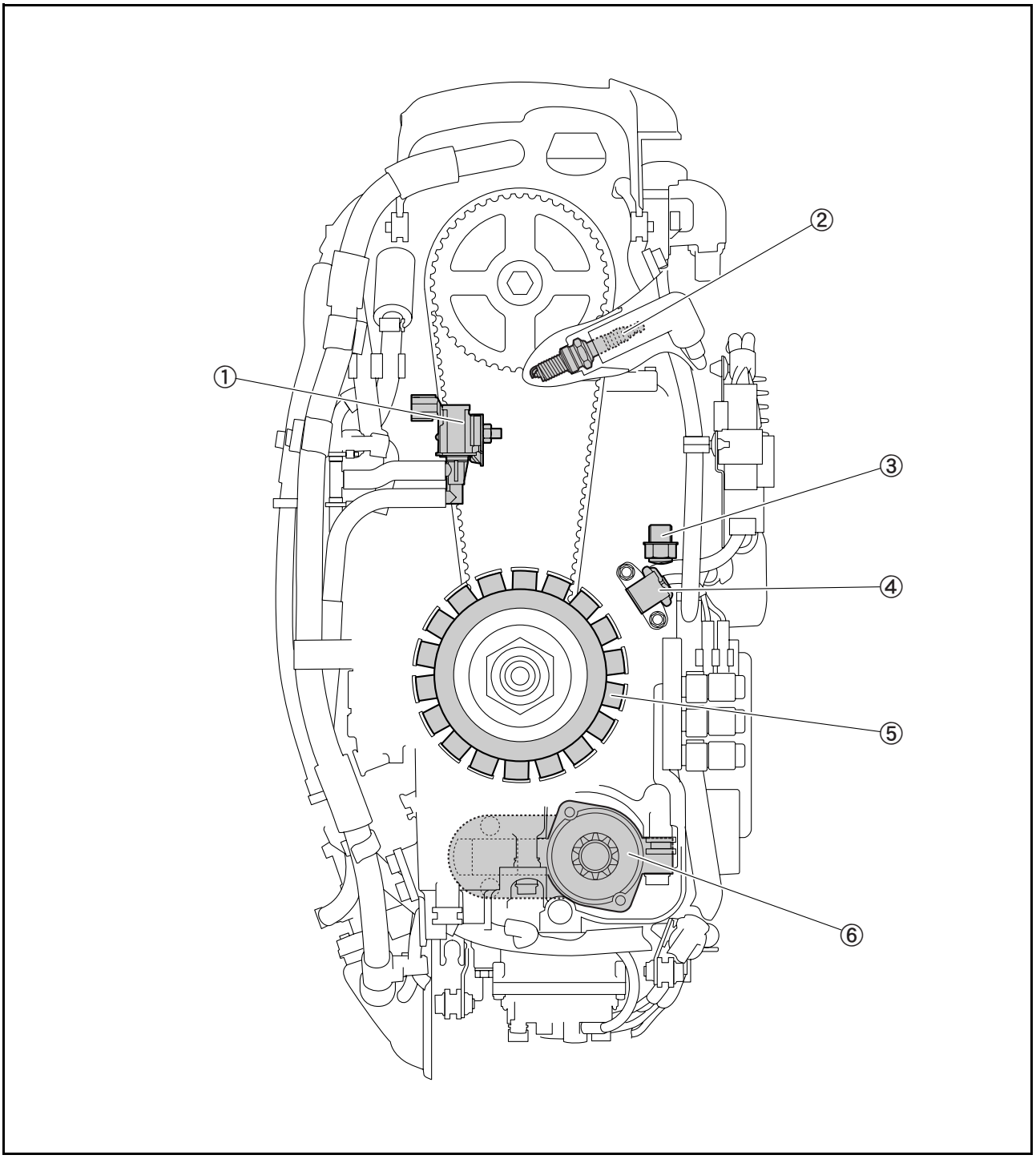
Rear view



① Speed sensor (option)
② Water detection switch
③ Fuel hose
④ Water detection switch lead

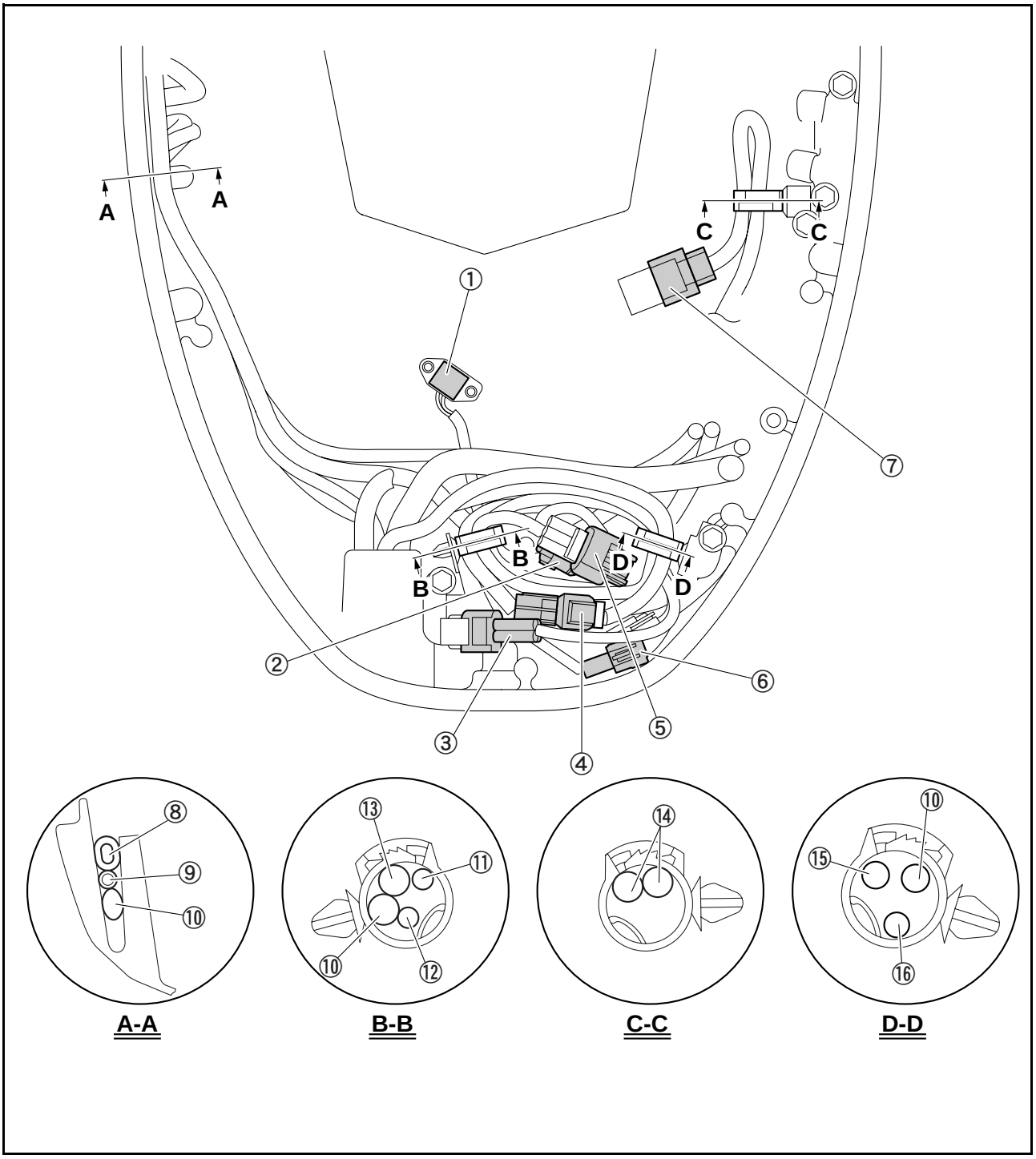
A Wind the water detection switch lead securing it with a clamp.

Top view



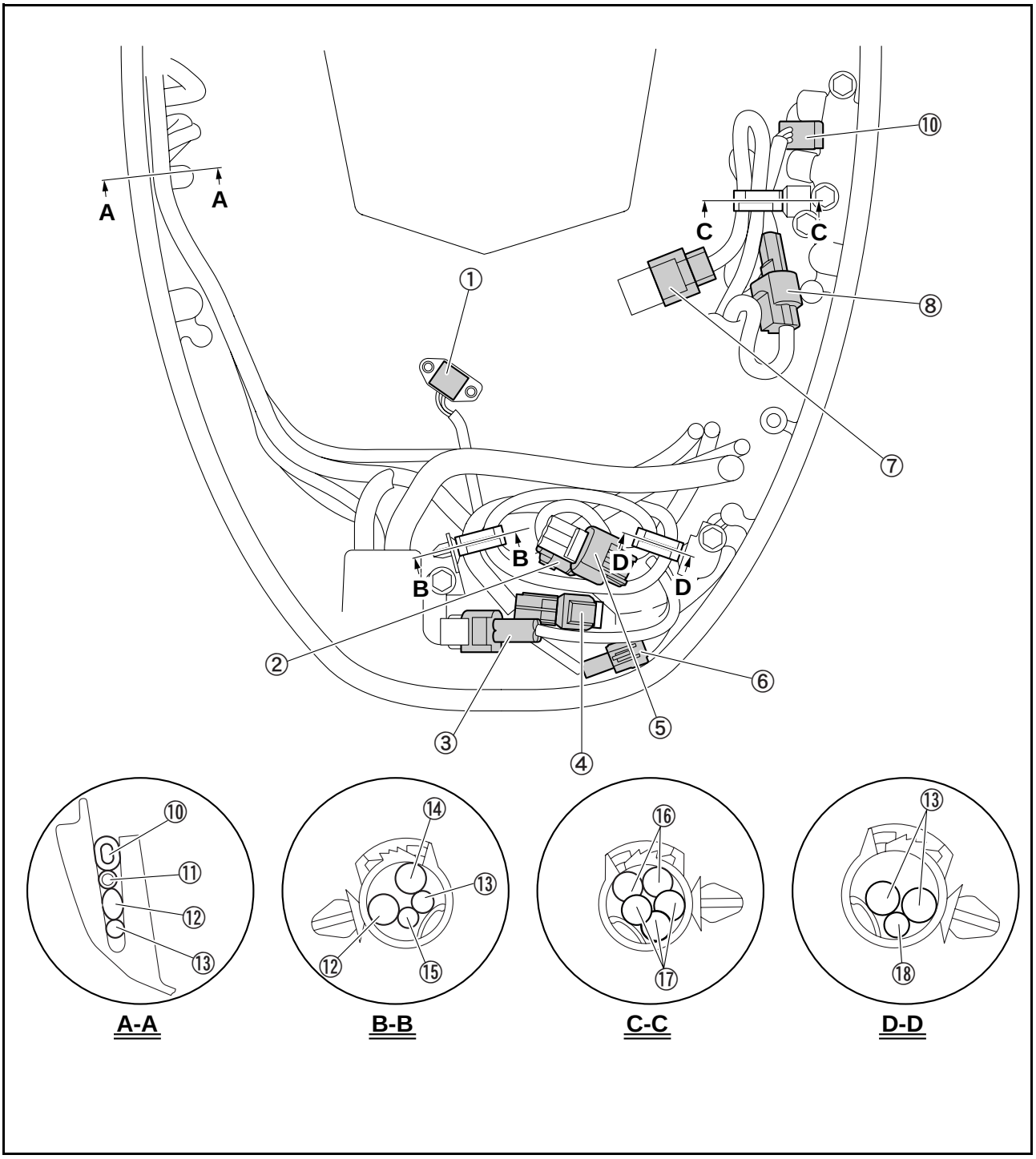
① Vapor shut-off valve
② Spark plug
③ Thermo sensor
④ Pulser coil
⑤ Lighting coil (stator assembly)
⑥ Starter motor

Bottom cowling (tiller handle model)



① Neutral switch
② Trim sensor coupler
③ 6Y8 Multifunction Meter communication coupler
④ Alert indicator coupler
⑤ Trolling switch coupler
⑥ Neutral switch coupler
⑦ Water pressure sensor coupler
⑧ Fuel hose
⑨ Speedometer hose
⑩ PTT motor lead (PTT model)
⑪ Trolling switch lead
⑫ Neutral switch lead
⑬ Alert indicator harness
⑭ Water pressure sensor lead
⑮ Sub wiring harness

Bottom cowling (remote control model)



① Neutral switch
② Trim sensor coupler
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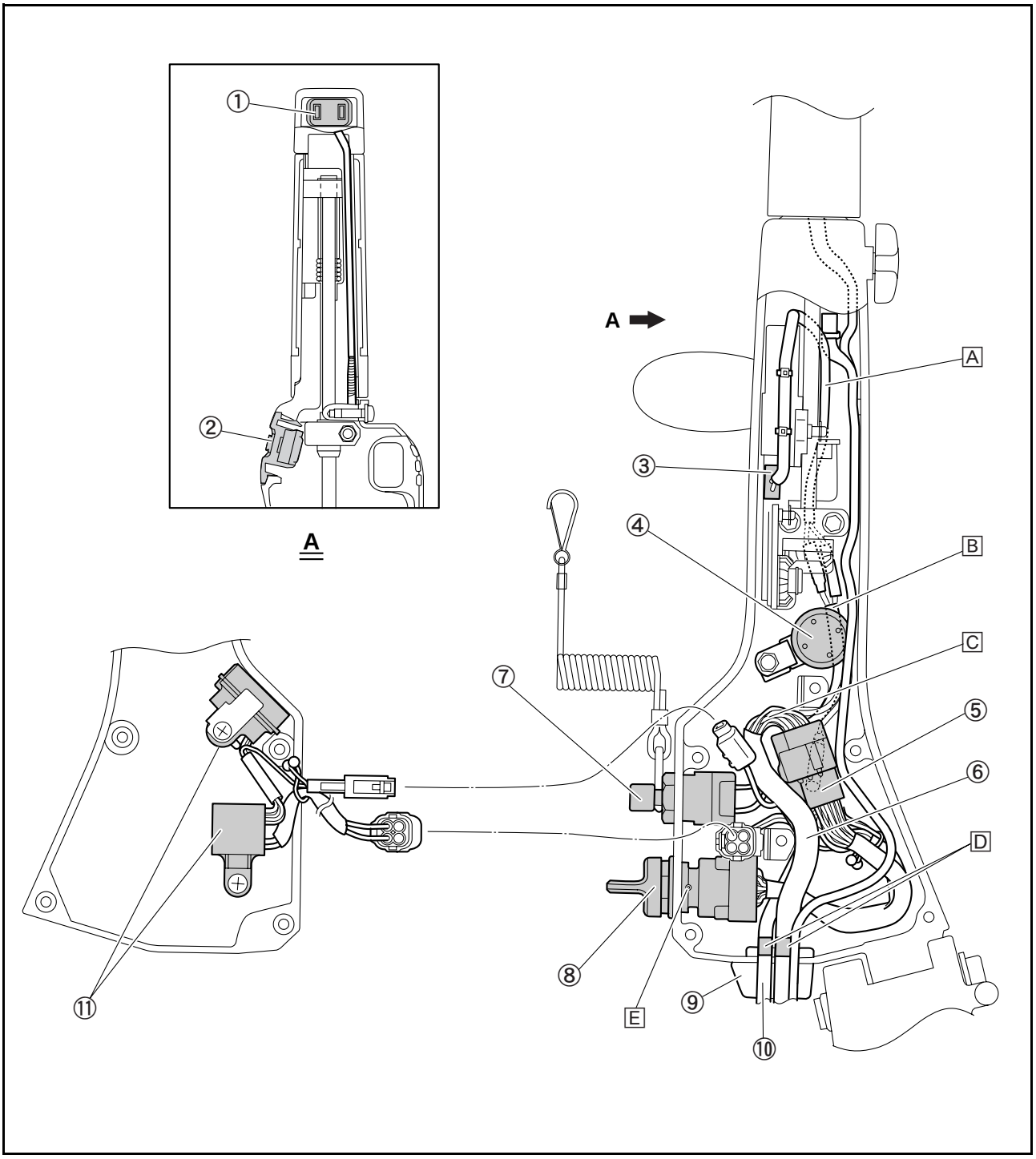
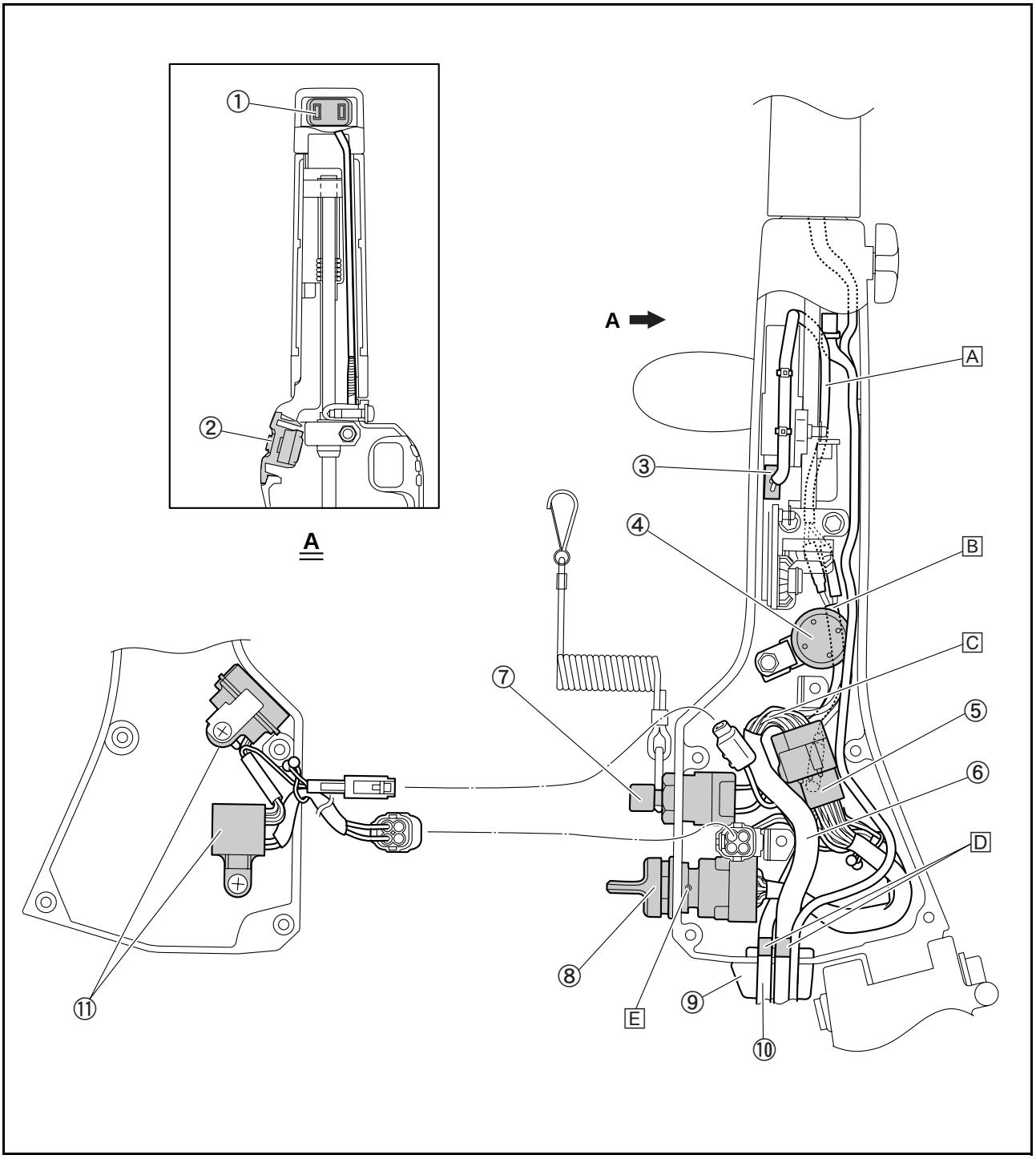
④ Alert indicator coupler
⑤ Trolling switch coupler
⑥ Neutral switch coupler
⑦ Water pressure sensor coupler
⑧ PTT switch coupler (PTT model)
⑨ PTT switch (PTT model)
⑩ Fuel hose
⑪ Speedometer hose
⑫ PTT motor lead (PTT model)
⑬ Trim sensor lead (PTT model)
⑭ Alert indicator harness
⑮ Neutral switch lead
⑯ Water pressure sensor lead
⑰ PTT switch lead (PTT model)
⑱ Sub wiring harness

Tiller handle (tiller handle model)



① PTT switch
② Trolling switch
③ Neutral switch
④ Alert buzzer
⑤ Engine start switch coupler
⑥ Extension wiring harness
⑦ Engine shut-off switch
⑧ Engine start switch
⑨ Grommet
⑩ Alert indicator harness
⑪ Alert indicator

A Run the neutral switch leads (blue and black) under the control link assembly.
B Run the neutral switch leads (brown) under the buzzer.



C Bend the extension wiring harness ⑥, and then connect the harness coupler. This harness bending position must be 10.0 mm (0.39 in) or more away from the engine start switch coupler ⑤. The bend radius should be 10.0 mm (0.39 in) or more.

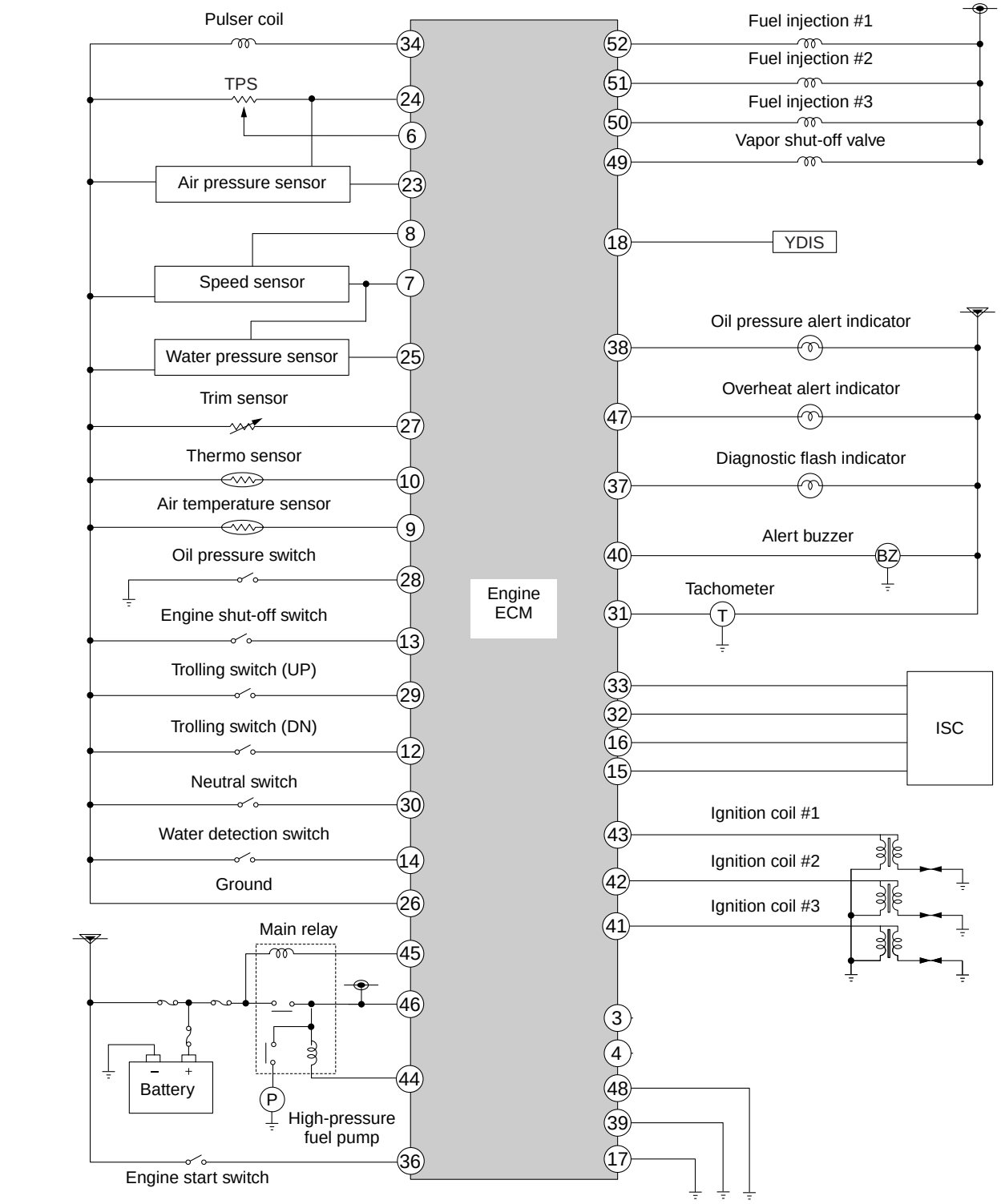
D Align the tape ends of the extension wiring harness ⑥ and the alert indicator harness ⑩ with the end of the grommet ⑨.

E Install the engine start switch ⑧ with the hole of the switch facing upward.

Circuit diagram

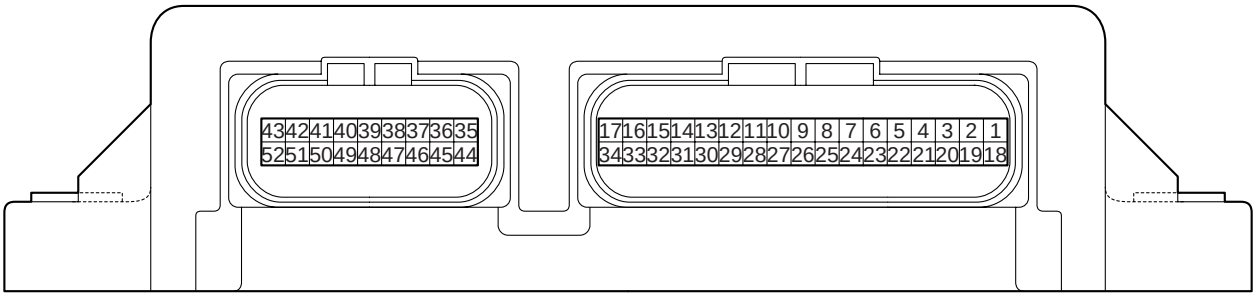
TIP:

The circled numbers in the illustration indicate the engine ECM terminal numbers.



The same marks are connected to each other.

ECM coupler layout



No.	Connecting part	Color
1		
2		
3	6Y8 Multifunction Meter	White
4	6Y8 Multifunction Meter	Blue
5		
6	TPS	Pink
7	Sensor power source	Orange
8	Speed sensor	Blue
9	Air temperature sensor	Black/Yellow
10	Thermo sensor	Black/Yellow
11		
12	Trolling switch (DN)	White/Blue
13	Engine shut-off switch	White
14	Water detection switch	Blue/White
15	ISC	Green
16	ISC	Green/Yellow
17	Ground	Black
18	YDIS	White/Black
19		
20		
21		
22		
23	Air pressure sensor	Pink/Green
24	Sensor power source	Orange
25	Water pressure sensor	Blue/Black
26	Sensor ground	Black
27	Trim sensor	Pink

No.	Connecting part	Color
28	Oil pressure switch	Pink/White
29	Trolling switch (UP)	Orange/White
30	Neutral switch	Blue/Green
31	Tachometer (remote control)	Green
32	ISC	Green/Black
33	ISC	Green/Red
34	Pulser coil	White/Red
35		
36	Engine start switch	Yellow
37	Diagnostic flash indicator	Blue/White
38	Oil pressure alert indicator	Pink/White
39	Ground	Black
40	Alert buzzer	Pink
41	Ignition coil #3	Black/Yellow
42	Ignition coil #2	Black/White
43	Ignition coil #1	Black/Orange
44	Main relay (high-pressure fuel pump)	Blue
45	Main relay	Yellow/Green
46	Main relay	Red/Yellow
47	Overheat alert indicator	Pink/Black
48	Ground	Black
49	Vapor shut-off valve	Green/Black
50	Fuel injector #3	Purple/Yellow
51	Fuel injector #2	Purple/Black
52	Fuel injector #1	Purple/Red

Checking the electrical component

Checking by use of YDIS

When checking the TPS, ISC, high-pressure fuel pump, fuel injector, or each sensor, use the YDIS.

When deleting the diagnosis record in the YDIS, be sure to check the time that the trouble codes were detected.

When checking the input voltage of a part, the coupler or connector must be disconnected. As a result, the engine ECM determines that the part is disconnected and a trouble code is detected. Therefore, be sure to delete the diagnosis record after checking the input voltage.

YDIS (CD-ROM, Ver. 1.32):
60V-WS853-05
YDIS (KIT): 60V-85300-05

TIP:

- Before checking the electrical components, make sure that the battery is fully charged.
- Install the proprietary YDIS software in CD-ROM to your computer. Always use the exclusive communication cable for connecting the engine ECM to the computer. For a description of the communication cable and CD-ROM to be used, see “YDIS” (4-1). Also, be sure to check the CD-ROM version before using it.
- To connect and operate the YDIS, see the “YDIS (Ver. 1.32 or later) Instruction Manual.”

Measuring the peak voltage

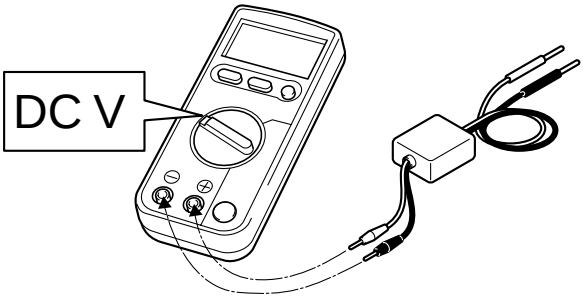
⚠ WARNING

When checking the peak voltage, do not touch any of the connections of the digital tester probes.

NOTICE

When testing the voltage between the terminals of an electrical component with the digital tester, do not allow any of the leads to touch any metal parts. If touched, the electrical component can be short-circuited and damaged.

To check the electrical components or measure the peak voltage, use the special service tools. A faulty electrical component can be easily checked by measuring the peak voltage. The specified engine speed when measuring the peak voltage is affected by many factors such as fouled spark plugs or a weak battery. If one of these factors is present, the peak voltage cannot be measured properly.



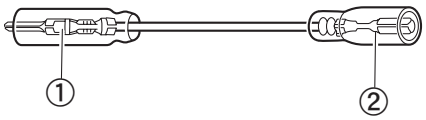
Digital circuit tester: 90890-03174
Peak voltage adapter B: 90890-03172

TIP:

- Before measuring the peak voltage, check all the wiring for proper connection and corrosion, and check that the battery is fully charged.
- Use the peak voltage adapter B with the recommended digital circuit tester.
- Connect the positive pin of the peak voltage adapter B to the positive terminal of the digital tester, and the negative pin to the negative terminal.
- When measuring the peak voltage, set the selector on the digital circuit tester to the **DC voltage mode.**

Checking by using the digital tester

The electrical technical data apply to the measurements taken by the Selva recommendation tester.
The resistance shown is the value taken before engine start. It may change depending on the environmental conditions and the ambient temperature.
Input voltage changes depending on the battery voltage.
If the tester probe cannot be inserted into the coupler, prepare a test lead suitable for the measurement.



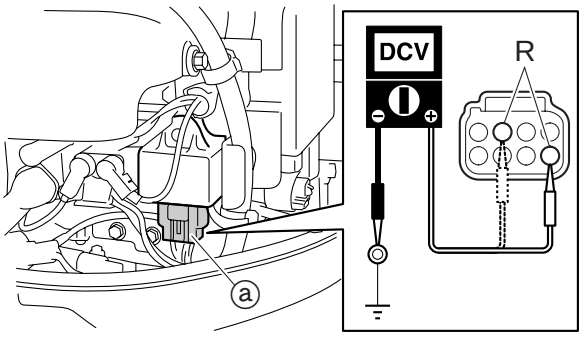
Digital circuit tester: 90890-03174
Test lead:
Terminal, male ①: (commercially available)
Terminal, female ②: (commercially available)

TIP:
Use a terminal ① of appropriate size for the coupler terminal to be measured. If a terminal of appropriate size is not available, adjust the width of the terminal ① with a grinder.

Engine control units and components

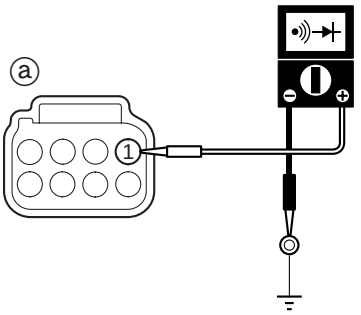
Checking the main relay

1. Disconnect the main relay coupler ⓐ.
2. Measure the input voltage between the terminals and the ground.



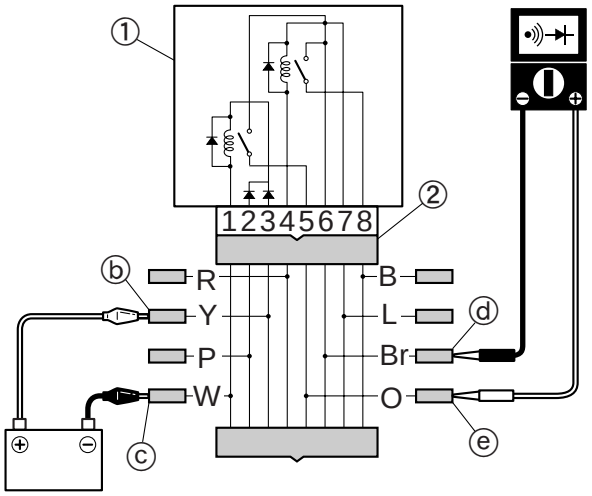
Main relay input voltage:
Red (R)–Ground
Red (R)–Ground
12.0 V (battery voltage)

3. Turn the engine start switch to “ON,” and then check the wiring harness for continuity.



Wiring harness continuity:
Terminal 1–Ground

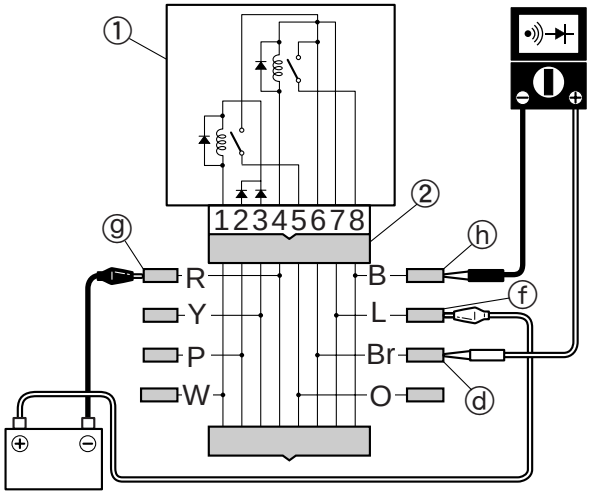
4. Turn the engine start switch to “OFF.”
5. Remove the main relay ①, and then connect the test harness (8 pins) ②.
6. Connect the positive battery lead to the terminal ⓑ and the negative battery lead to the terminal ⓒ, and then check for continuity between the terminals ⓓ and ⓔ. Replace the relay if out of specification. ***NOTICE:*** **Do not reverse the battery leads.**



Test harness (8 pins) ②: 90890-06879

Battery lead	Terminal	
	ⓓ	ⓔ
Connect	○	○
Disconnect		

7. Connect the positive battery lead to the terminal ⓕ and the negative battery lead to the terminal ⓖ, and then check for continuity between the terminals ⓗ and ⓓ. Replace the relay if out of specification. ***NOTICE:*** **Do not reverse the battery leads.**



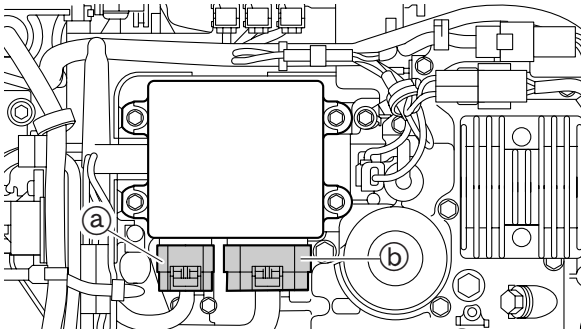
Battery lead	Terminal	
	ⓓ	ⓗ
Connect	○	○
Disconnect		

8. Disconnect the test harness ②.

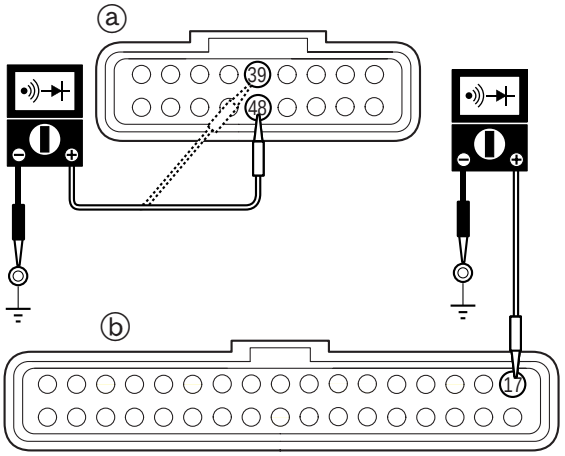
9. Install the main relay ①, and then connect the main relay coupler ⓐ.

Checking the engine ECM circuit

1. Disconnect the engine ECM couplers ⓐ and ⓑ.

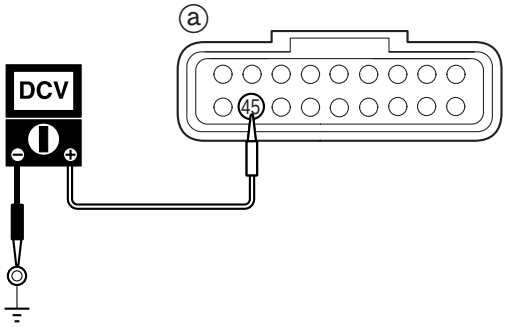


2. Check for continuity between the engine ECM coupler terminals and the ground.



Wiring harness continuity:
Terminal 39–Ground Terminal 48–Ground Terminal 17–Ground

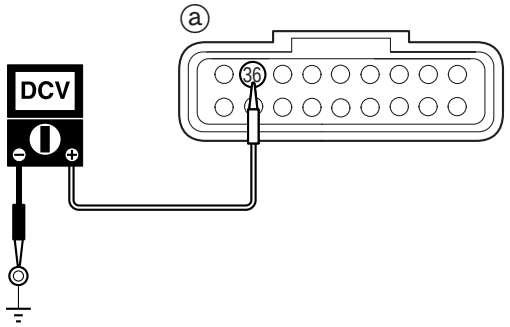
3. Measure the input voltage between the engine ECM coupler terminal 45 and the ground.



5

Engine ECM input voltage:
Terminal 45–Ground
12.0 V (battery voltage)

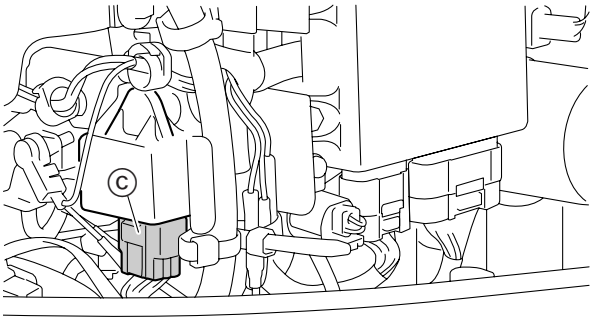
4. Turn the engine start switch to “ON,” and then measure the input voltage between the engine ECM coupler terminal 36 and the ground.



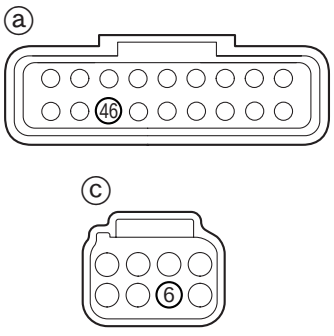
Engine ECM input voltage:
Terminal 36–Ground
12.0 V (battery voltage)

5. Turn the engine start switch to “OFF.”

6. Disconnect the main relay coupler ⓒ.



7. Check the wiring harness for continuity.



Wiring harness continuity:
Terminal 46–Terminal 6

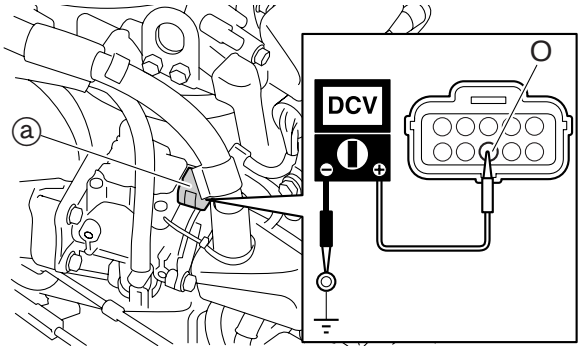
8. Connect the main relay coupler ⓒ and the engine ECM couplers ⓐ and ⓑ.

Checking the throttle body

The TPS, the air pressure sensor, the air temperature sensor, and the ISC are the components of the throttle body.

1. Disconnect the throttle body coupler ⓐ.

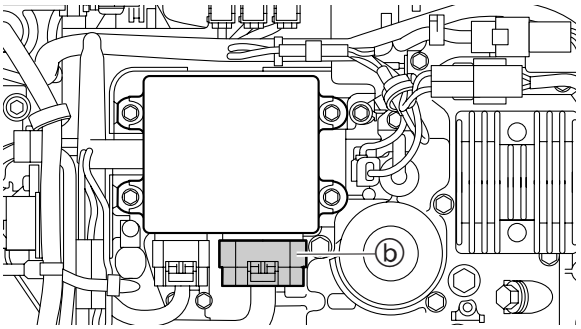
2. Turn the starter switch to “ON,” and then measure the throttle body input voltage.



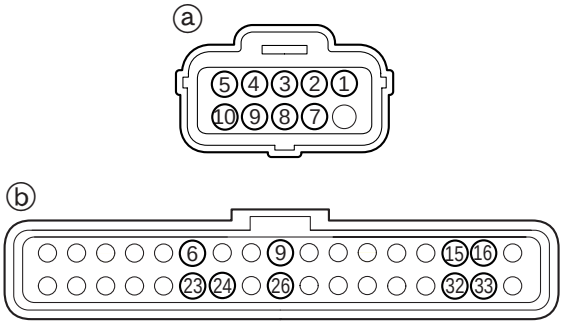
Throttle body input voltage:
Orange (O)–Ground
4.75 V–5.25 V

3. Turn the engine start switch to “OFF.”

4. Disconnect the engine ECM coupler ⓑ.



5. Check the wiring harness for continuity.



Wiring harness continuity:
ⓐTerminal 1–ⓑTerminal 9
ⓐTerminal 2–ⓑTerminal 26
ⓐTerminal 3–ⓑTerminal 23
ⓐTerminal 4–ⓑTerminal 15
ⓐTerminal 5–ⓑTerminal 16
ⓐTerminal 7–ⓑTerminal 6
ⓐTerminal 8–ⓑTerminal 24
ⓐTerminal 9–ⓑTerminal 32
ⓐTerminal 10–ⓑTerminal 33

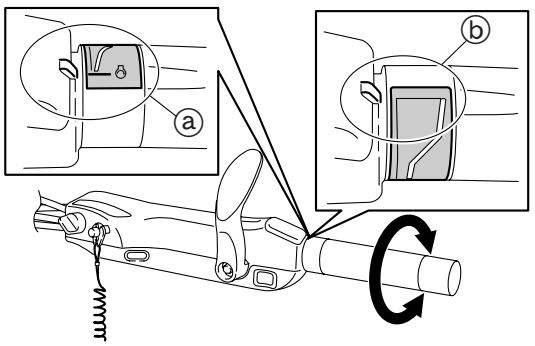
6. Connect the engine ECM coupler ⓑ and the throttle body coupler ⓐ.

Checking the TPS

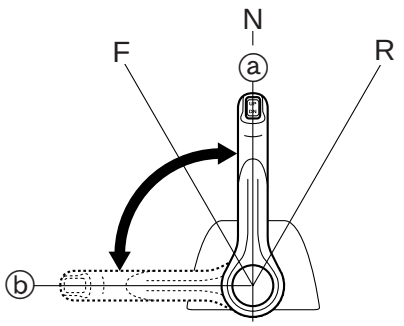
The TPS is a component of the throttle body which cannot be disassembled.

1. Connect the YDIS to display "TPS voltage."
2. Start the engine and warm it up, and then turn it off.
3. Turn the engine start switch to "ON," and then measure the output voltages of the TPS and the throttle valve opening angle when the remote control lever is at the fully closed position ⓐ and the fully open position ⓑ.

A



B



A Tiller handle model
B Remote control model

TPS output voltage and throttle valve opening angle (reference data):		
	Fully closed ⓐ	Fully open ⓑ
Output voltage	0.674 V	3.680 V
Opening angle	0.1°	75.3°

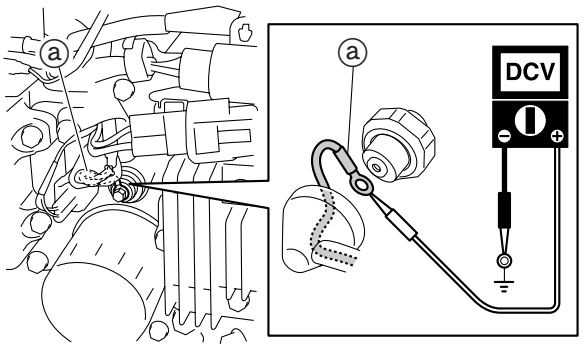
Checking the ISC

The ISC is a component of the throttle body which cannot be disassembled.

1. Check the operation of the ISC using the YDIS "Stationary test" and check the operating sound.
2. Start the engine, and then check the engine speed increases using the YDIS "Active test."

Checking the oil pressure switch

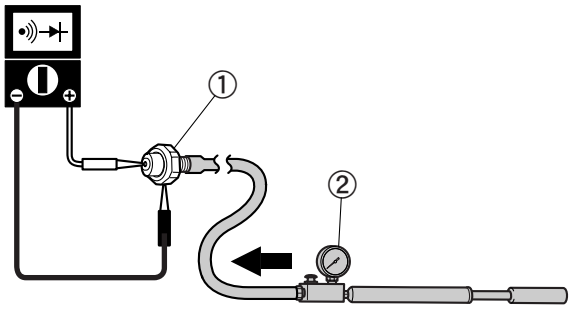
1. Remove the oil pressure switch lead ⓐ.
2. Turn the engine start switch to "ON," and then measure the oil pressure switch input voltage.



Oil pressure switch input voltage:
Pink/White (P/W)–Ground
12.0 V (battery voltage)

3. Turn the engine start switch to "OFF."
4. Remove the oil pressure switch ①.
5. Connect the special service tool ② to the oil pressure switch ①.

6. Apply positive pressure to the oil pressure switch ① slowly, and then check that continuity changes to no continuity in the range of the working pressure. Replace the oil pressure switch if the continuity does not change to no continuity in the working pressure range.

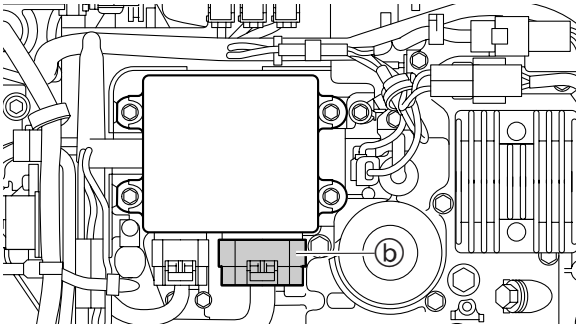


Leakage tester ②: 90890-06840

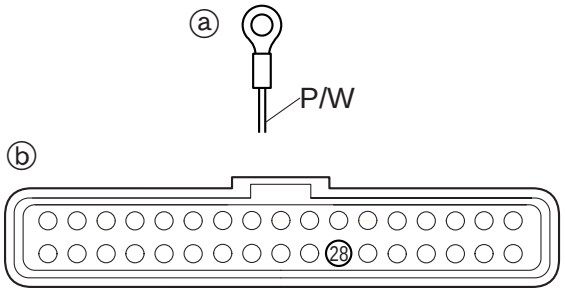
Working pressure: 29.4–58.8 kPa (0.294–0.588 kgf/cm², 4.3–8.5 psi)

7. Disconnect the special service tool ②.

8. Disconnect the engine ECM coupler ⓑ.



9. Check the wiring harness for continuity.



Wiring harness continuity: Pink/White (P/W)–Terminal 28

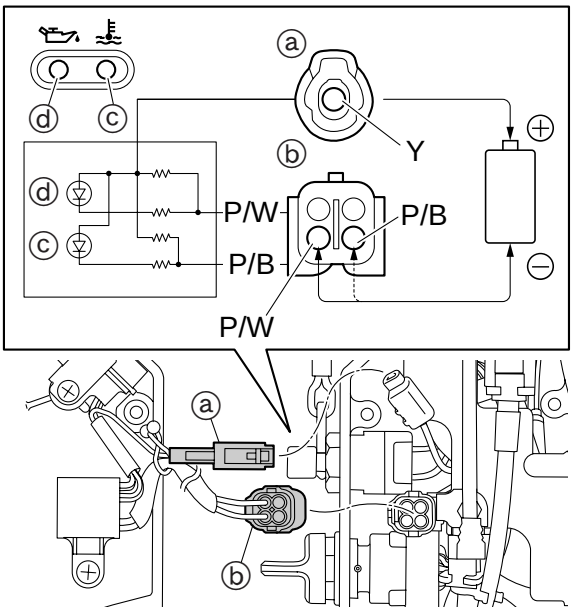
10. Connect the engine ECM coupler ⓑ.

11. Install the oil pressure switch ① and the oil pressure switch lead ⓐ. See “Installing the oil pressure switch” (7-50).

Checking the alert indicator (tiller handle model)

1. Remove the tiller handle cover, and then disconnect the alert indicator couplers ⓐ and ⓑ.

2. Connect the battery (1.5 V) to the alert indicator couplers ⓐ and ⓑ. Check that the overheat alert indicator ⓒ or the oil pressure alert indicator ⓓ comes on. Replace the alert indicator if it does not come on. ***NOTICE:*** **Do not apply a voltage higher than 1.7 V when checking the LED.**

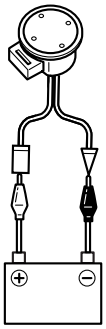


Lighting-up	Terminal	Battery
Overheat alert indicator ⓒ	Yellow (Y)	⊕
	Pink/Black (P/B)	⊖
Oil pressure alert indicator ⓓ	Yellow (Y)	⊕
	Pink/White (P/W)	⊖

3. Connect the alert indicator couplers ⓐ and ⓑ, and then install the tiller handle cover.

Checking the alert buzzer

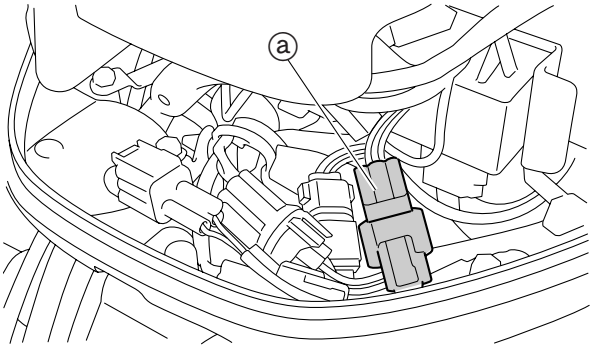
1. Remove the alert buzzer.
2. Connect the battery leads to the alert buzzer connectors, and then check that the alert buzzer comes on. Replace the alert buzzer if it does not come on.



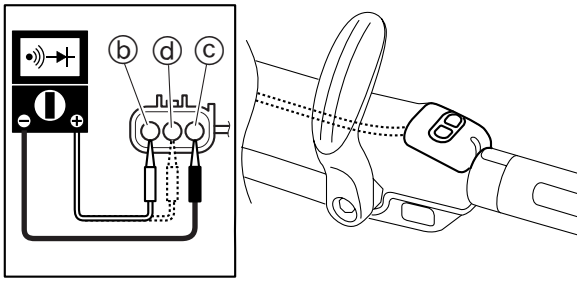
3. Install the alert buzzer.

Checking the trolling switch

1. Disconnect the trolling switch coupler ⓐ.

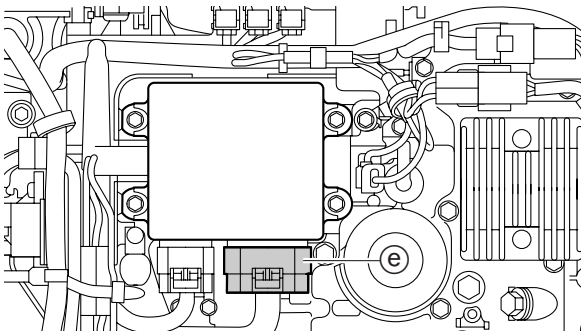


2. Check the trolling switch for continuity. Replace the trolling switch if out of specification.

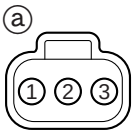


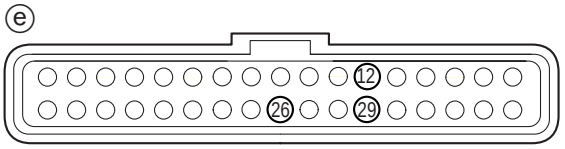
Switch position	Terminal		
	ⓑ	ⓒ	ⓓ
UP		○——	——○
Free			
DN	○——	——○	

3. Disconnect the engine ECM coupler ⓔ.



4. Check the wiring harness for continuity.





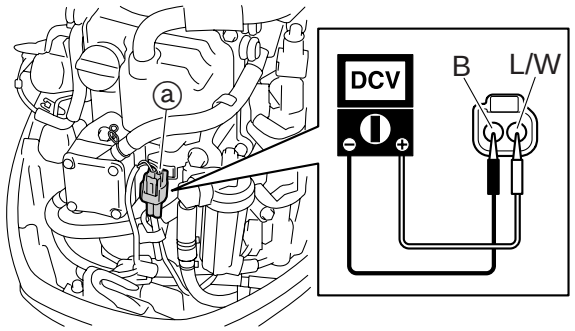
Wiring harness continuity:
Terminal 1–Terminal 26
Terminal 2–Terminal 29
Terminal 3–Terminal 12

5. Connect the engine ECM coupler ⓔ and the trolling switch coupler ⓐ.

Fuel control units and components

Checking the water detection switch

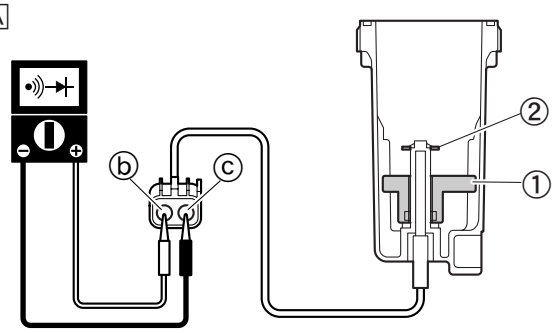
1. Disconnect the water detection switch coupler ⓐ.
2. Turn the engine start switch to “ON,” and then measure the input voltage at the water detection switch coupler.



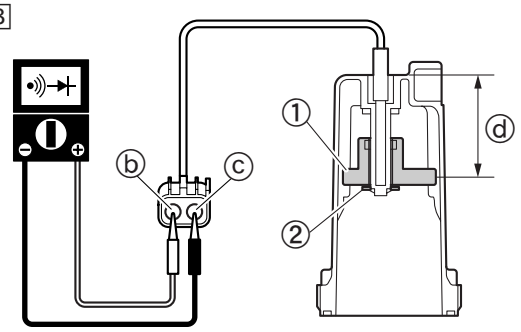
Water detection switch input voltage:
Blue/White (L/W)–Black (B)
4.75–5.25 V

3. Turn the engine start switch to "OFF," and then remove the filter cup assembly.
4. Check that the float ① moves smoothly.
5. Check the water detection switch for continuity with the float in positions A and B.
NOTICE: **Do not remove the clip ② and the float ①.**

A



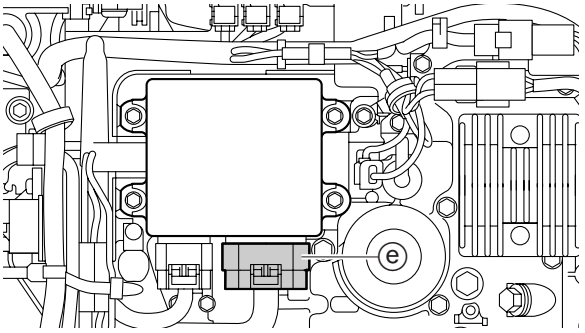
B



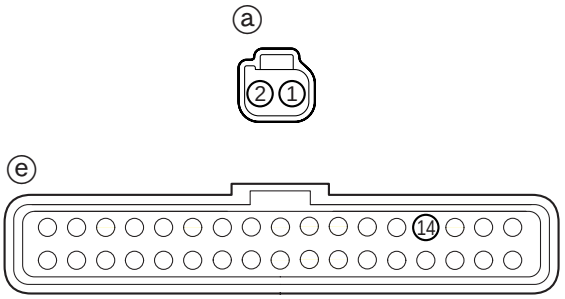
Float position	Terminal	
	ⓑ	ⓒ
A		
B	○——	——○

Float height ⓓ (reference data):
19.4 mm (0.76 in)

6. Disconnect the engine ECM coupler ⓔ.



7. Check the wiring harness for continuity.

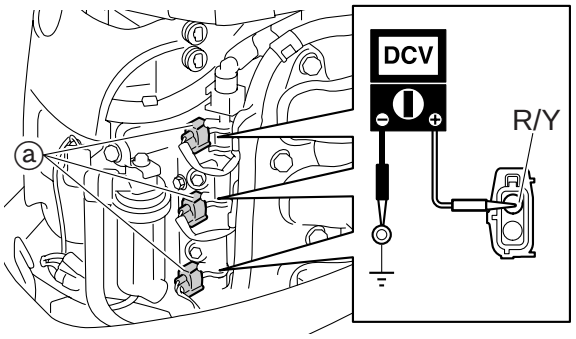


Wiring harness continuity:
Terminal 1–Terminal 14
Terminal 2–Ground

8. Connect the engine ECM coupler ⓔ.
9. Install the filter cup assembly. See "Fuel filter assembly" (6-7).
10. Connect the water detection switch coupler ⓐ.

Checking the fuel injector

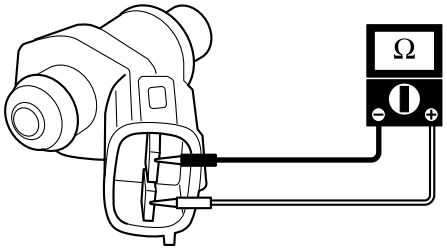
1. Check the fuel injector operation using the YDIS "Stationary test" and check the operating sound.
2. Disconnect the fuel injector couplers ⓐ.
3. Turn the engine start switch to "ON," and then measure the input voltage between the fuel injector coupler terminal and the ground.



Fuel injector input voltage:
Red/Yellow (R/Y)–Ground
12.0 V (battery voltage)

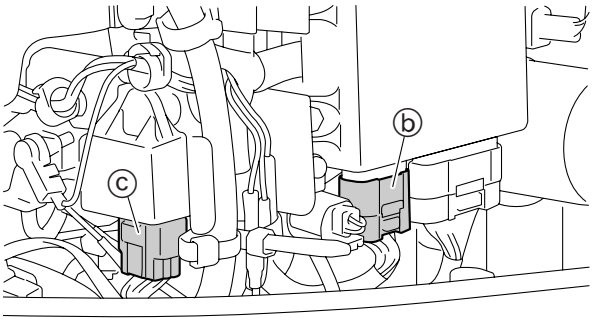
4. Turn the engine start switch to “OFF.”

5. Measure the fuel injector resistance.

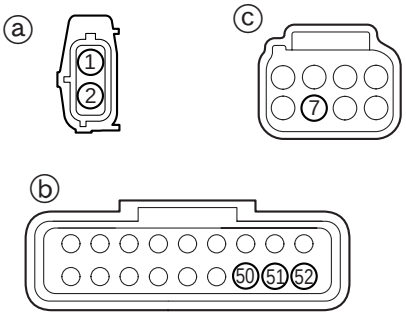


Fuel injector resistance (reference data):
12.0 Ω at 20 °C (68 °F)

6. Disconnect the engine ECM coupler ⓑ and the main relay coupler ⓒ.



7. Check the wiring harness for continuity.



Wiring harness continuity:
Fuel injector #1
Terminal 1–Terminal 7
Terminal 2–Terminal 52
Fuel injector #2
Terminal 1–Terminal 7
Terminal 2–Terminal 51
Fuel injector #3
Terminal 1–Terminal 7
Terminal 2–Terminal 50

8. Connect the engine ECM coupler ⓑ and the main relay coupler ⓒ.

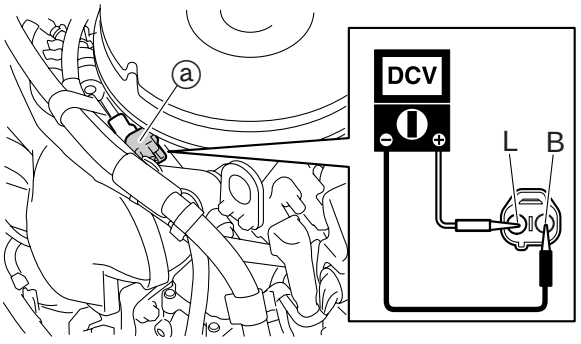
9. Connect the fuel injector couplers ⓐ.

Checking the high-pressure fuel pump

1. Check the operation of the high-pressure fuel pump using the YDIS “Stationary test” and check the operating sound.

2. Disconnect the high-pressure fuel pump coupler ⓐ.

3. Connect the tester probes to the high-pressure fuel pump coupler terminals, and then measure the input voltage within 3 seconds after turning the engine start switch to “ON.”

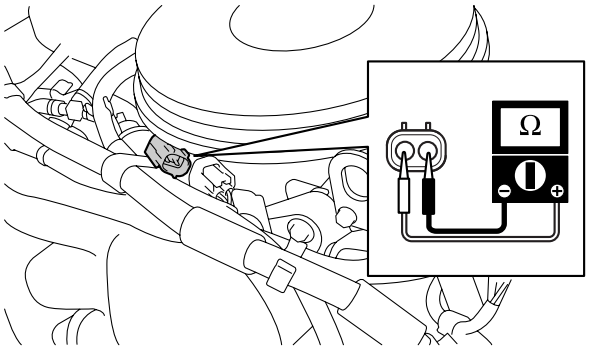


5

High-pressure fuel pump input voltage:
Blue (L)–Black (B)
12.0 V (battery voltage)

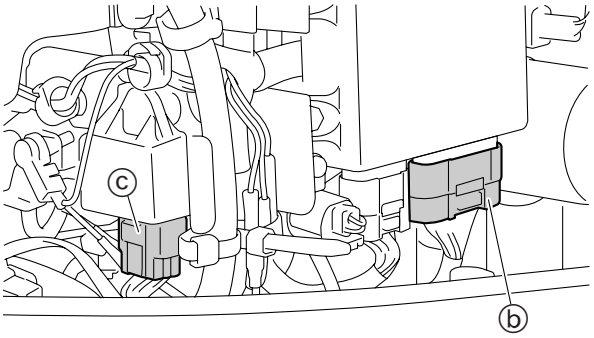
4. Turn the engine start switch to “OFF.”

5. Measure the resistance of the high-pressure fuel pump motor.

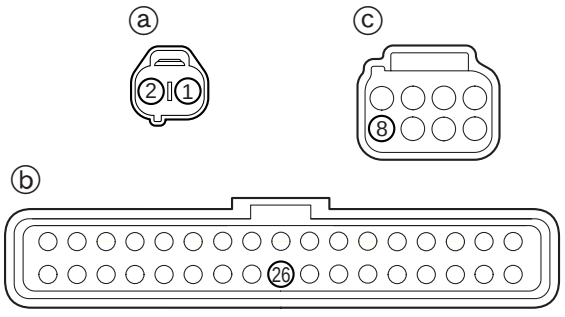


High-pressure fuel pump resistance (reference data):
1.4–1.7 Ω at 20 °C (68 °F)

6. Disconnect the engine ECM coupler ⓑ and the main relay coupler ⓒ.



7. Check the wiring harness for continuity.



Wiring harness continuity:
Terminal 1–Terminal 26
Terminal 2–Terminal 8

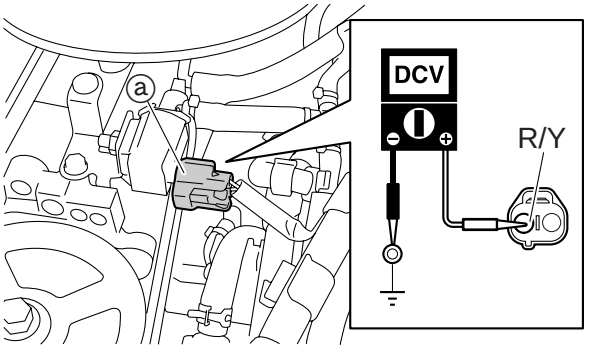
8. Connect the engine ECM coupler ⓑ and the main relay coupler ⓒ.

9. Connect the high-pressure fuel pump coupler ⓐ.

Checking the vapor shut-off valve

1. Disconnect the vapor shut-off valve coupler ⓐ.

2. Turn the engine start switch to “ON,” and then measure the input voltage between the vapor shut-off valve coupler terminal and ground.

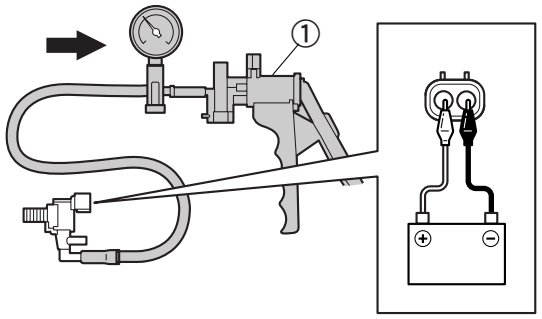


Vapor shut-off valve input voltage:
Red/Yellow (R/Y)–Ground
12.0 V (battery voltage)

3. Remove the vapor shut-off valve, and then connect the special service tool ① to the vapor shut-off valve.

4. Apply the specified negative pressure to the vapor shut-off valve.

5. Check that the vapor shut-off valve opens and the negative pressure is released when the battery voltage is applied to the vapor shut-off valve terminals. ***NOTICE:*** **Apply the battery voltage to the vapor shut-off valve terminals for only a few seconds.**



Vacuum/pressure pump gauge set ①: 90890-06756

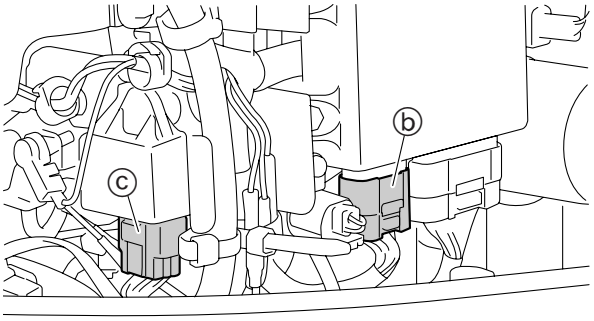
Specified negative pressure: 67.0 kPa (0.67 kgf/cm², 9.7 psi)

6. Remove the special service tool ①.

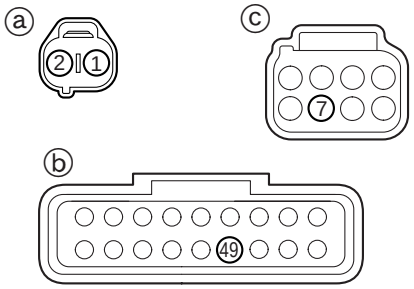
7. Measure the resistance between the vapor shut-off valve terminals.

Vapor shut-off valve resistance: 30.0–34.0 Ω at 20 °C (68 °F)

8. Disconnect the engine ECM coupler ⓑ and the main relay coupler ⓒ.



9. Check the wiring harness for continuity.



Wiring harness continuity:
Terminal 1–Terminal 49
Terminal 2–Terminal 7

10. Install the vapor shut-off valve, and then connect the vapor shut-off valve coupler ⓐ.

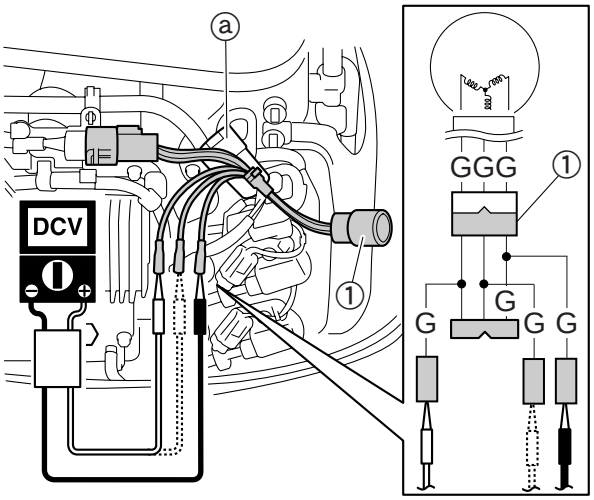
11. Connect the engine ECM coupler ⓒ and the main relay coupler ⓑ.

Charging units and components

Checking the lighting coil (stator assembly)

1. Disconnect the Rectifier Regulator coupler ⓐ, and then connect the test harness (3 pins) ①.

2. Measure the lighting coil output peak voltage between all combinations of the terminals. Replace the stator assembly if below specification.



Test harness (3 pins) ①: 90890-06870

Lighting coil output peak voltage: Green (G)–Green (G)			
r/min	Unloaded		
	Cranking	1500	3500
DC V	14.0	45.0	102.0

TIP:

To prevent the engine from starting when cranking it, make sure to remove the clip from the engine shut-off switch.

3. Measure the lighting coil resistance.

Lighting coil resistance (reference data): 0.561–0.759 Ω at 20 °C (68 °F)

4. Disconnect the test harness ①, and then connect the Rectifier Regulator coupler ⓐ.

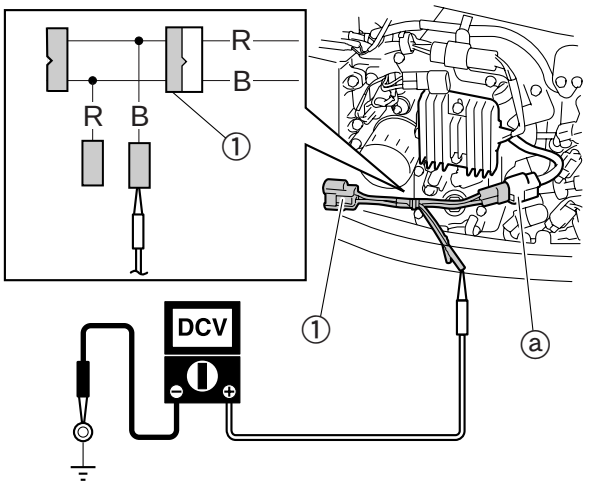
Checking the Rectifier Regulator

NOTICE

If the battery cables are connected in reverse, the Rectifier Regulator can be damaged.

1. Disconnect the Rectifier Regulator coupler ⓐ, and then connect the test harness (2 pins) ①.

2. Measure the Rectifier Regulator output peak voltage.



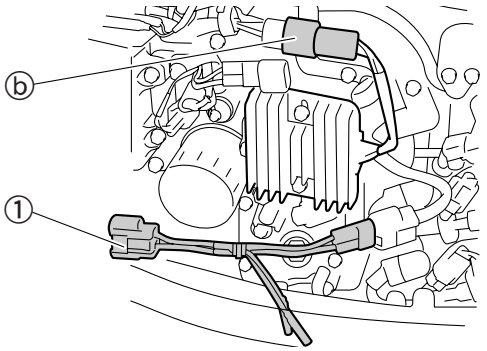
Test harness (2 pins) ①: 90890-06887

TIP:

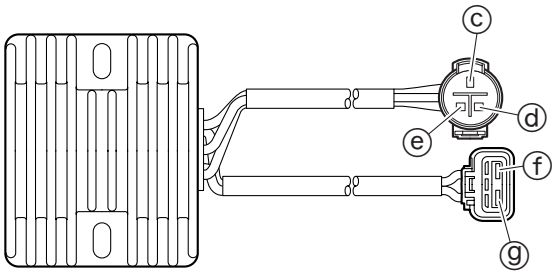
Do not use peak voltage adapter B when measuring the Rectifier Regulator output peak voltage.

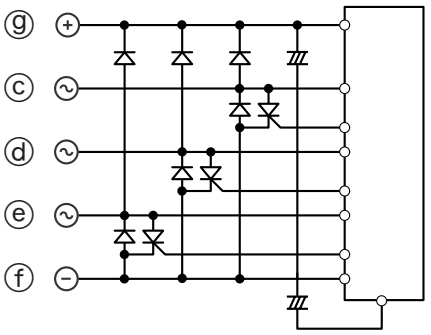
Rectifier Regulator output peak voltage: Red (R)–Ground		
r/min	Unloaded	
	1500	3500
DC V	13.0	13.0

3. Disconnect the test harness ① and the Rectifier Regulator coupler ⓑ.



4. Check the Rectifier Regulator for continuity. Replace if out of specification.





Rectifier Regulator continuity (testing diode mode):		
Tester probe		Display value (reference data)
⊕	⊖	
ⓒ	ⓖ	0.439
ⓓ	ⓖ	0.439
ⓔ	ⓖ	0.440
ⓒ	ⓕ	OL
ⓓ	ⓕ	OL
ⓔ	ⓕ	OL
ⓖ	ⓒ	OL
ⓖ	ⓓ	OL
ⓖ	ⓔ	OL
ⓕ	ⓖ	0.767
ⓕ	ⓒ	0.440
ⓕ	ⓓ	0.441
ⓕ	ⓔ	0.440

OL: Indicates overload

TIP:
Make sure to set the tester measurement range to the diode mode.

5. Connect the Rectifier Regulator couplers ⓐ and ⓑ.

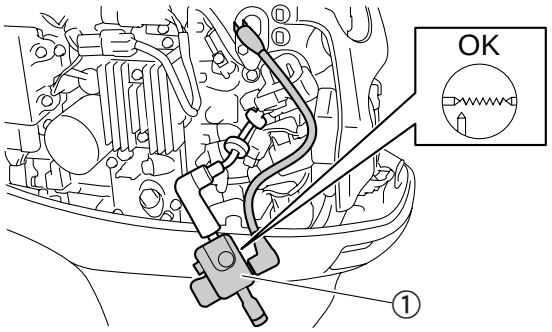
Ignition units and components

Checking the ignition spark

1. Disconnect the spark plug caps from the spark plugs.

2. Connect a spark plug cap to the special service tool ①.

3. Check the ignition spark using the YDIS "Stationary test." **WARNING! Do not touch any of the special service tool connections.**



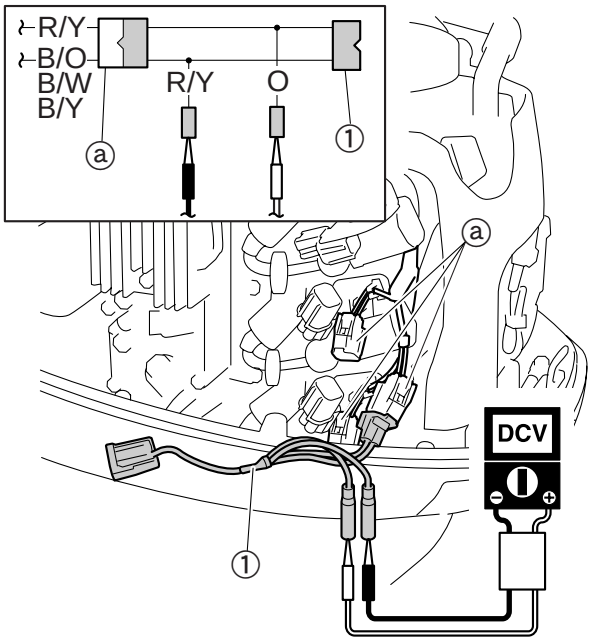
Ignition tester (spark gap tester) ①:
90890-06754

4. Remove the special service tool ①, and then connect the spark plug caps.

Checking the engine ECM

1. Disconnect the ignition coil couplers ⓐ and then connect the test harness (2 pins) ①.

2. Measure the engine ECM output peak voltage.

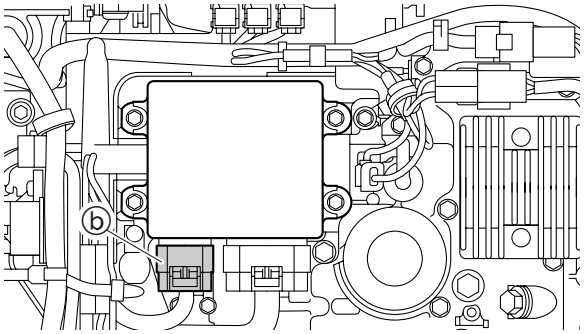


Test harness (2 pins) ①: 90890-06861

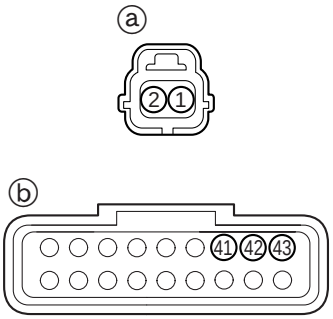
Engine ECM output peak voltage:
#1: Black/Orange (B/O)–Black (B)
#2: Black/White (B/W)–Black (B)
#3: Black/Yellow (B/Y)–Black (B)
100.0 V at cranking (unloaded)

3. Disconnect the test harness ①.

4. Disconnect the engine ECM coupler ⓑ.



5. Check the wiring harness for continuity.



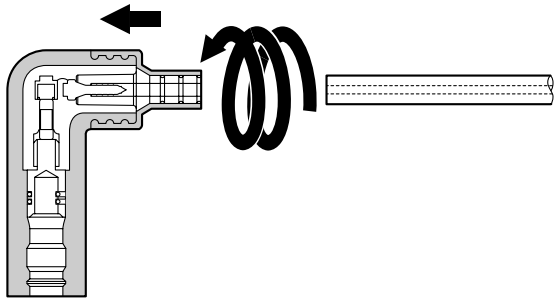
Wiring harness continuity:
Ignition coil #1
Terminal 1–Ground
Terminal 2–Terminal 43
Ignition coil #2
Terminal 1–Ground
Terminal 2–Terminal 42
Ignition coil #3
Terminal 1–Ground
Terminal 2–Terminal 41

6. Connect the engine ECM coupler ⓑ.

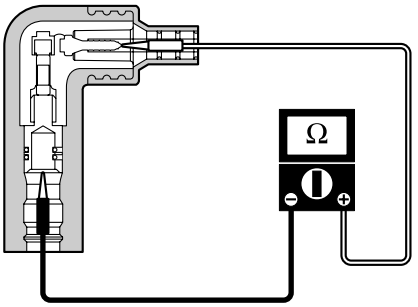
7. Connect the ignition coil couplers ⓐ.

Checking the spark plug cap

1. Remove the spark plug caps from the spark plug wires by turning the caps counterclockwise.



2. Measure the spark plug cap resistance.



Spark plug cap resistance (reference data):
5.0 kΩ at 20 °C (68 °F)

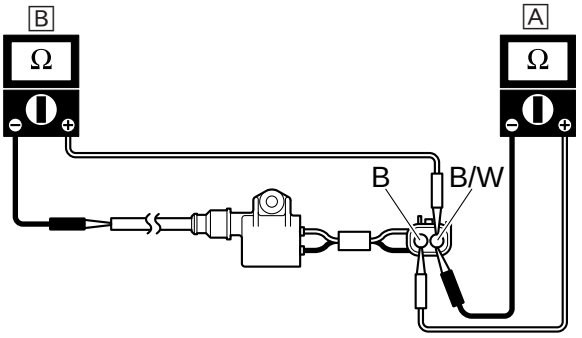
3. Install the spark plug caps to the spark plug wires by turning the caps clockwise.

Checking the ignition coil

1. Disconnect the ignition coil couplers.

2. Remove the spark plug caps.

3. Measure the ignition coil resistance.



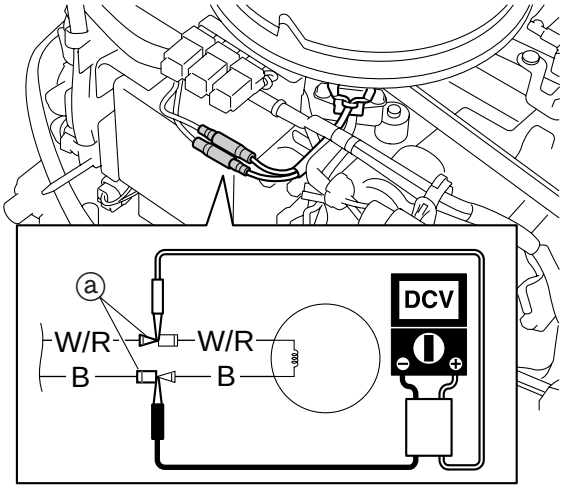
Ignition coil resistance:
A Primary coil (reference data):
0.1789–0.2415 Ω at 20 °C (68 °F)
B Secondary coil:
3.256–4.884 kΩ at 20 °C (68 °F)

4. Install the spark plug caps.

5. Connect the ignition coil couplers.

Checking the pulser coil

1. Measure the pulser coil output peak voltage.



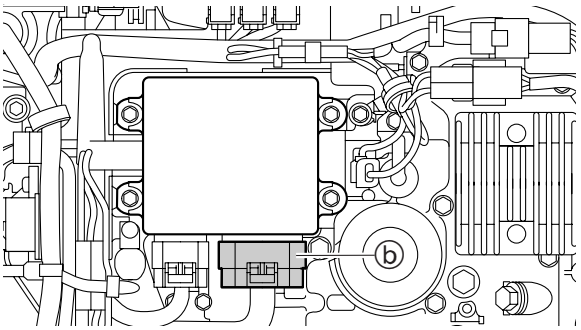
Pulser coil output peak voltage: White/Red (W/R)–Black (B)				
r/min	Unloaded	Loaded		
	Cranking		1500	3500
DC V	5.0	2.7	6.5	9.8

TIP:
- When measuring the pulser coil output peak voltage under the unloaded cranking condition, disconnect the connectors ⓐ.
- When measuring the pulser coil output peak voltage under the loaded cranking condition, remove the clip from the engine shut-off switch to prevent the engine from starting.

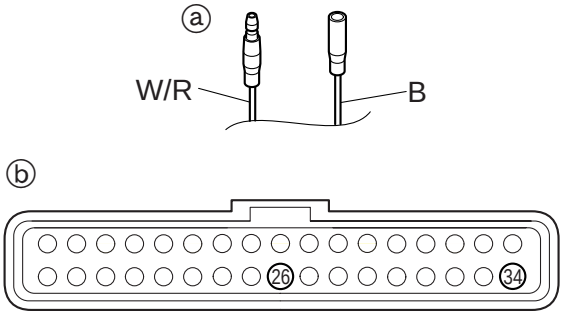
2. Disconnect the pulser coil connectors ⓐ, and then measure the pulser coil resistance.

Pulser coil resistance:
152.0–228.0 Ω at 20 °C (68 °F)

3. Disconnect the engine ECM coupler ⓑ.



4. Check the wiring harness for continuity.



Wiring harness continuity:
White/Red (W/R)–Terminal 34 Black (B)–Terminal 26

5. Connect the engine ECM coupler ⓑ and pulser coil connector ⓐ.

Checking the air temperature sensor

The air temperature sensor is a component of the throttle body which cannot be disassembled.

1. Measure the ambient temperature.
2. Connect the YDIS to display “Intake temperature” (air temperature).
3. Check that the difference between the ambient temperature and the displayed intake temperature is within ± 5 °C (± 9 °F).

TIP:
- Check the air temperature sensor when the engine is cold.
- When checking the air temperature sensor, remove the top cowling and do not start the engine.

Checking the air pressure sensor

The air pressure sensor is a component of the throttle body which cannot be disassembled.

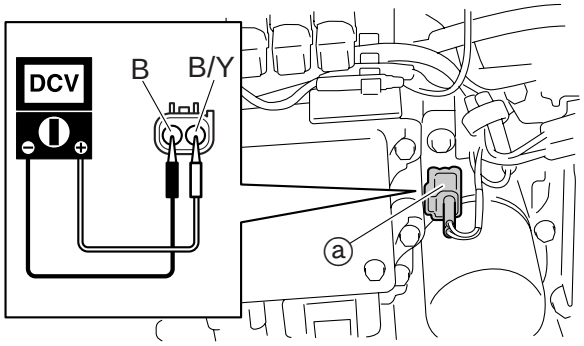
1. Connect the YDIS to display “Intake pressure.”
2. Start the engine and warm it up, and then measure the intake air pressure.

5

Checking the thermo sensor

1. Disconnect the thermo sensor coupler ⓐ.

2. Turn the engine start switch to “ON,” and then measure the input voltage at the thermo sensor coupler.

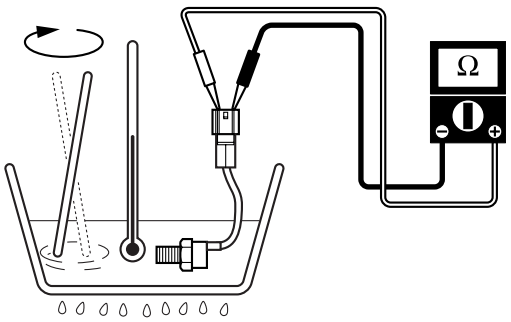


Thermo sensor input voltage:
Black/Yellow (B/Y)–Black (B)
4.75–5.25 V

3. Turn the engine start switch to “OFF.”

4. Remove the thermo sensor.

5. Place the thermo sensor in a container of water and heat the water slowly.

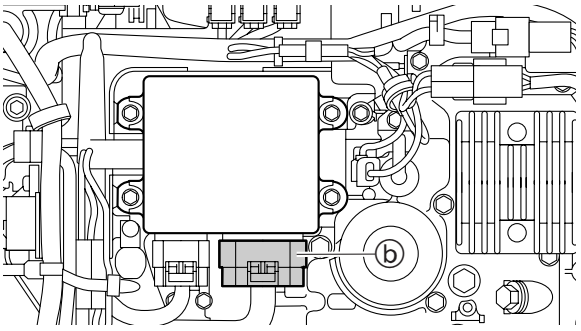


6. Measure the thermo sensor resistance.

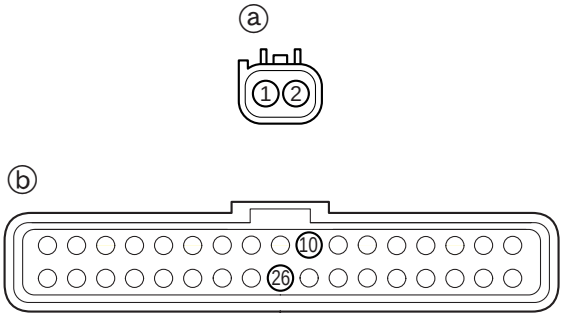
Thermo sensor resistance (reference data):
at 20 °C (68 °F): 26.460 kΩ
at 75 °C (167 °F): 0.370 kΩ
at 90 °C (194 °F): 240.3 Ω

7. Install the thermo sensor. See “Installing the thermo sensor” (7-50).

8. Disconnect the engine ECM coupler ⓑ.



9. Check the wiring harness for continuity.



Wiring harness continuity:
Terminal 1–Terminal 26
Terminal 2–Terminal 10

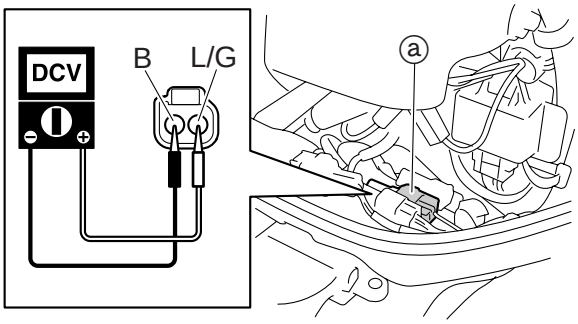
10. Connect the engine ECM coupler ⓑ.

11. Connect the thermo sensor coupler ⓐ.

Checking the neutral switch

1. Disconnect the neutral switch coupler ⓐ.

2. Turn the engine start switch to “ON,” and then measure the input voltage.

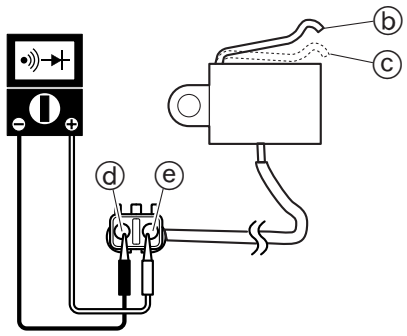


Neutral switch input voltage (reference data):
Blue/Green (L/G)–Black (B)
11.1 V

3. Turn the engine start switch to “OFF.”

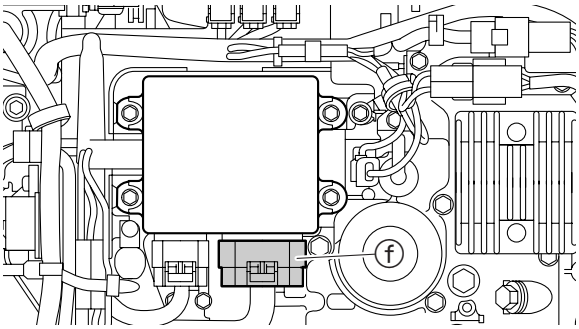
4. Remove the neutral switch.

5. Check the neutral switch continuity.

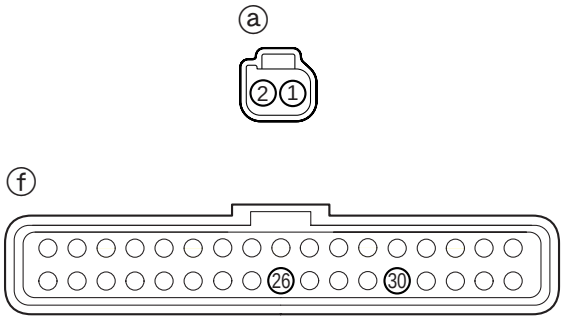


Neutral switch continuity:		
Position	Terminal	
	d	e
b		
c	○	○

6. Disconnect the engine ECM coupler ⓕ.



7. Check the wiring harness for continuity.



Wiring harness continuity:
Terminal 1–Terminal 30 Terminal 2–Terminal 26

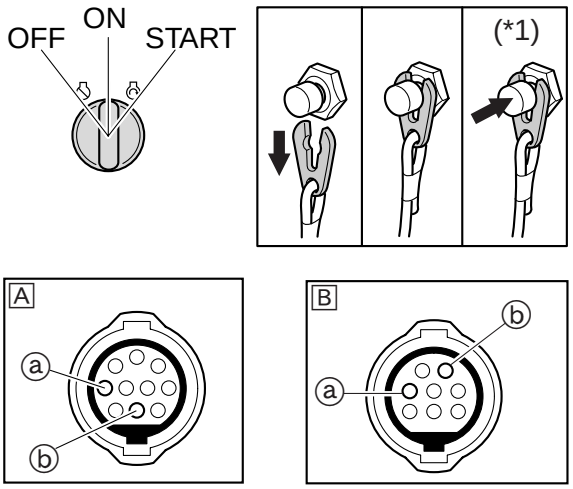
8. Connect the engine ECM coupler ⓕ.

9. Install the neutral switch, and then connect the neutral switch coupler ⓐ.

Checking the engine shut-off switch

1. Disconnect the 10-pin or the engine start switch coupler.

2. Turn the engine start switch to “ON,” and then check the engine shut-off switch for continuity.



A Tiller handle model and 703 remote control model
B 704 remote control model

Switch position	Terminal	
	a	b
Clip removed	○	○
Clip installed		
Button pushed in (*1)	○	○

(*1) Tiller handle model only

3. Turn the engine start switch to “OFF.”

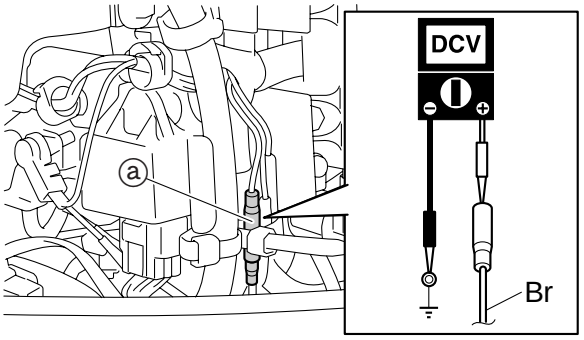
4. Connect the 10-pin or the engine start switch coupler.

Starting units and components

Checking the starter relay

1. Disconnect the starter relay connector ⓐ.

2. Turn the engine start switch to “START,” and then measure the starter relay input voltage.

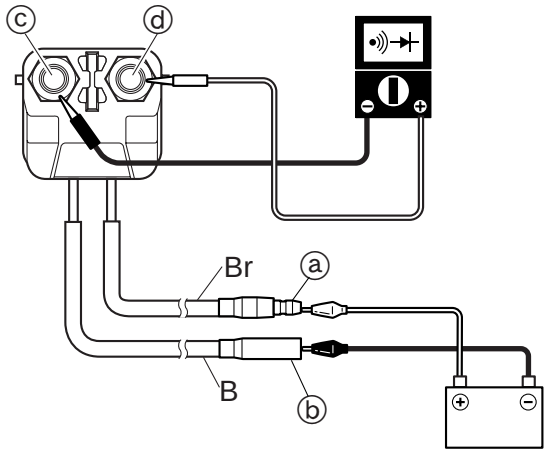


Starter relay input voltage:
Brown (Br)–Ground
12.0 V (battery voltage)

3. Turn the engine start switch to “OFF.”

4. Disconnect the starter relay leads, and then remove the starter relay. ***NOTICE:*** **Always disconnect the negative battery terminal before disconnecting the starter relay terminals.**

5. Connect the positive battery lead to the relay connector ⓐ, and the negative battery lead to the relay lead ⓑ, and then check for continuity between terminals ⓒ and ⓓ. Replace the starter relay if out of specification.



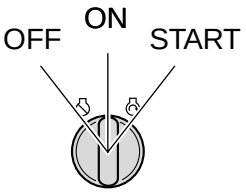
Battery lead	Terminal	
	ⓒ	ⓓ
Connect	○——	——○
Disconnect		

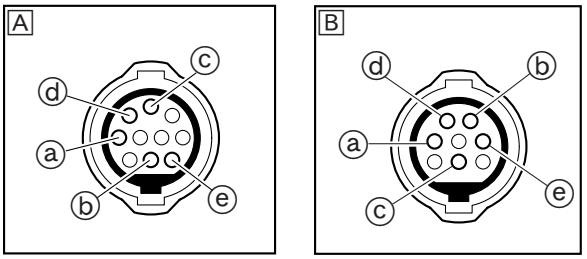
6. Install the starter relay, and then connect the starter relay leads.

Checking the engine start switch

1. Disconnect the 10-pin or engine start switch coupler.

2. Check the engine start switch for continuity.





A Tiller handle model and 703 remote control model
B 704 remote control model

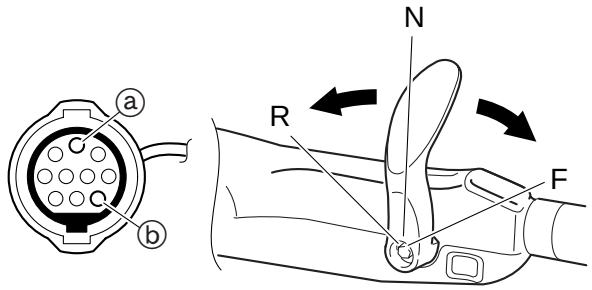
Switch position	Terminal				
	ⓐ	ⓑ	ⓒ	ⓓ	ⓔ
OFF	○——	——○			
ON			○——	——○	
START			○——	——○	——○

3. Connect the 10-pin or the engine start switch coupler.

Checking the neutral switch (tiller handle model)

1. Disconnect the 10-pin coupler.

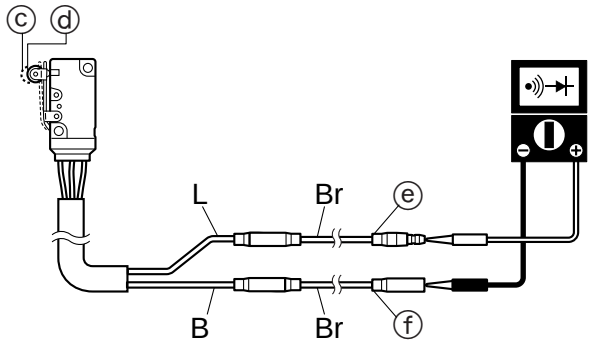
2. Turn the engine start switch to “START,” and then check the neutral switch for continuity at the shift lever positions F, N, and R.



Lever position	Terminal	
	ⓐ	ⓑ
F		
N	○———	———○
R		

3. Remove the neutral switch.

4. Check the neutral switch for continuity.

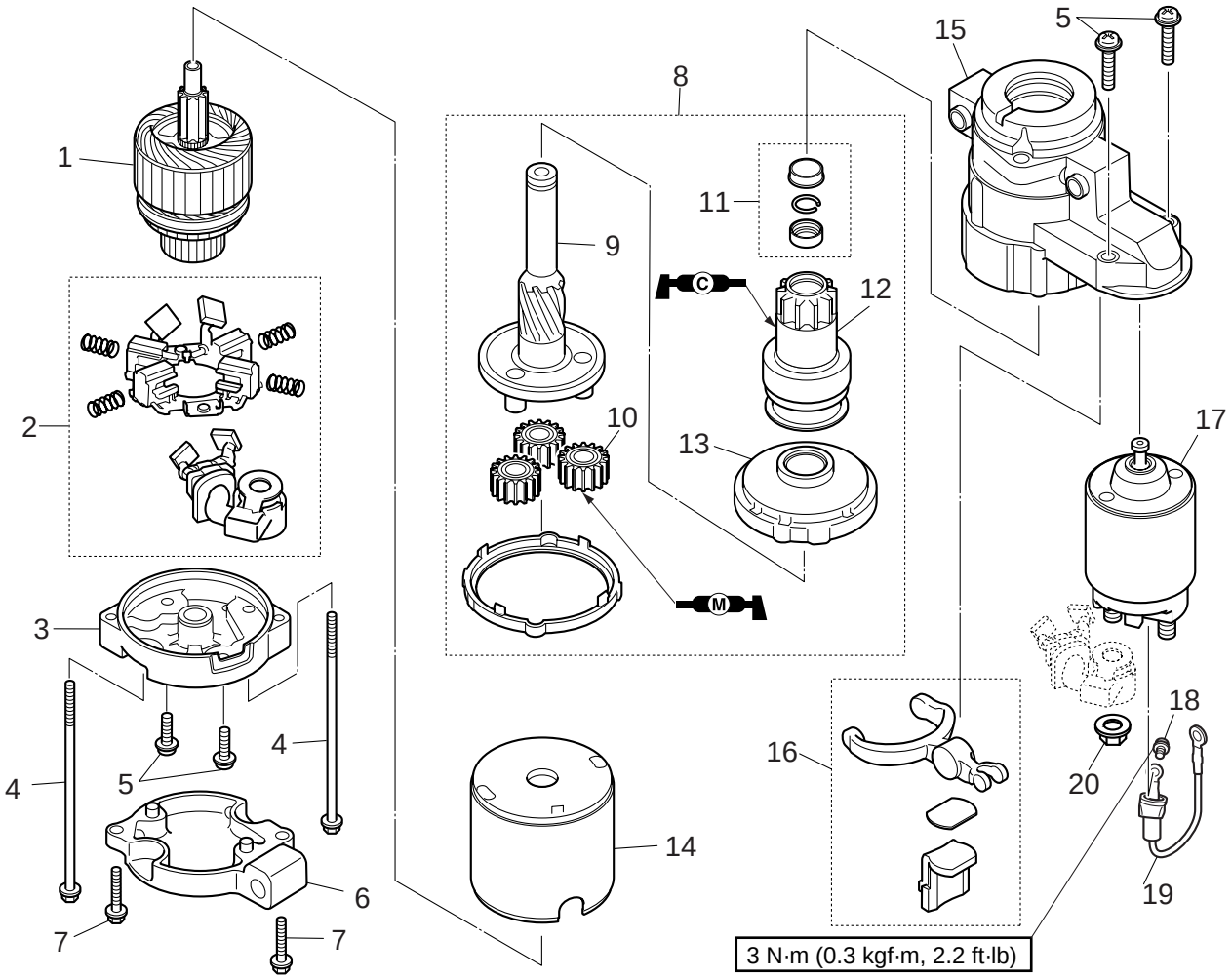


Switch position	Terminal	
	ⓔ	ⓕ
ⓒ		
ⓓ	○———	———○

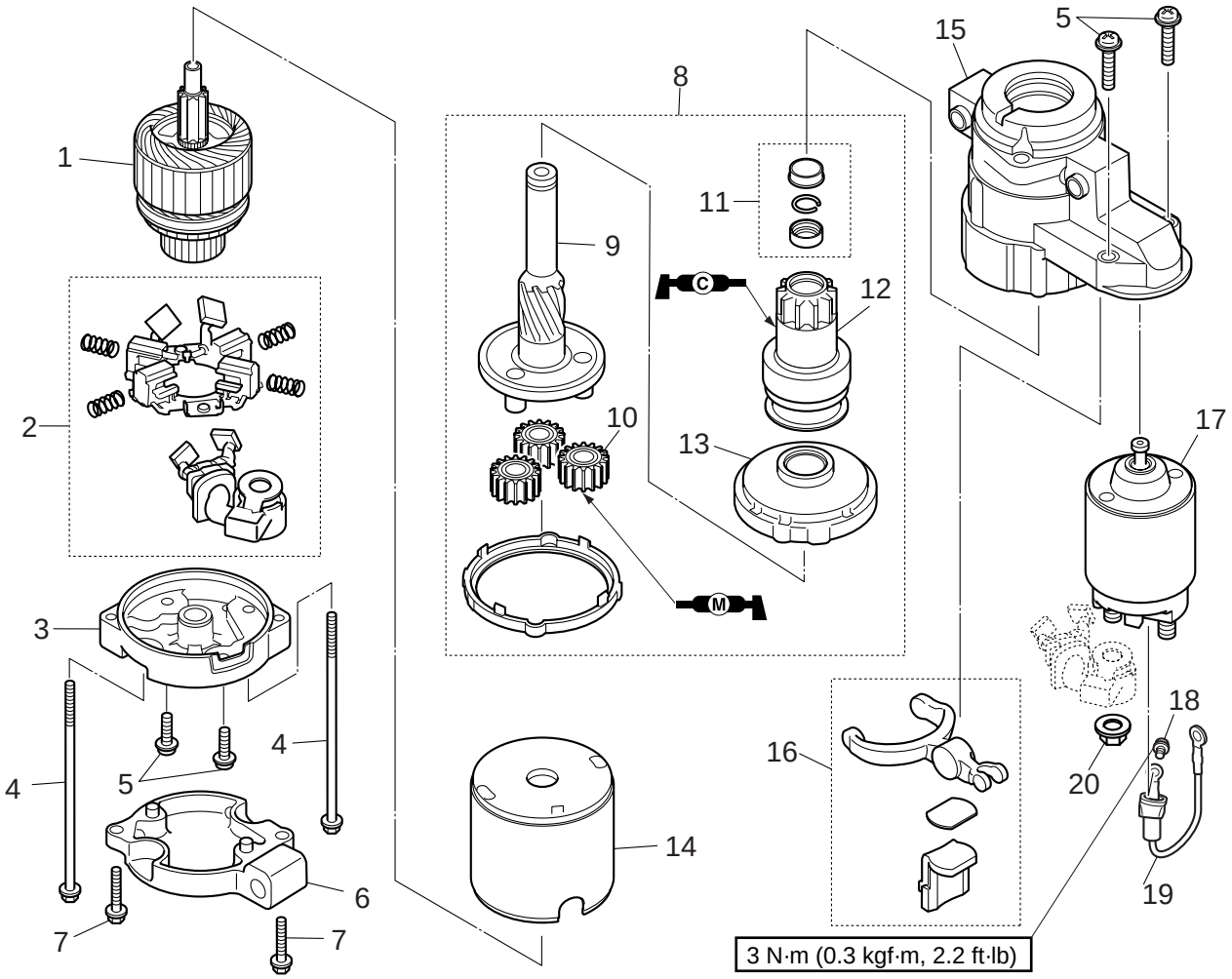
5. Install the neutral switch. See “Assembling the tiller handle” (9-9).

6. Connect the 10-pin coupler.

Starter motor



No.	Part name	Q'ty	Remarks
1	Armature	1	
2	Brush holder assembly	1	
3	Bracket	1	
4	Bolt	2	M5 × 105 mm
5	Screw set	1	M6 × 25 mm, Cover screw M5 × 8 mm, Bracket screw
6	Bracket	1	
7	Bolt	2	M5 × 25 mm
8	Starting motor gear assembly	1	
9	Pinion shaft	1	
10	Planetary gear	3	
11	Pinion stopper set	1	
12	Clutch assembly	1	
13	Outer gear	1	
14	Stator	1	
15	Cover assembly	1	
16	Lever assembly	1	



No.	Part name	Q'ty	Remarks
17	Magnet switch	1	
18	Screw	1	M5 × 7 mm
19	Lead	1	
20	Nut	1	

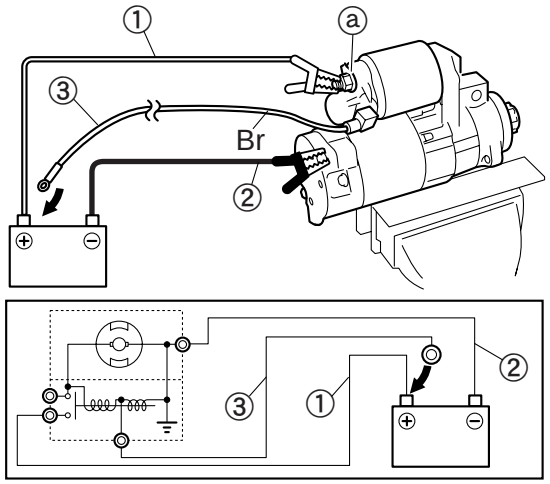
Removing the starter motor

1. Remove the starter motor from the power unit. See “Removing the starter motor” (7-29).

Checking the starter motor operation

1. Connect the positive battery cable ① to the magnet switch terminal ⓐ, and then connect the negative battery cable ② to the starter motor body.

2. Connect the starter motor Brown (Br) lead ③ to the positive battery terminal, and then check the starter motor operation. **WARNING! Do not touch the starter motor pinion.**



TIP:

- Check the starter motor operation for a few seconds.
- If the starter motor is disassembled for maintenance, make sure to check the operation again after assembling it.

3. Disconnect the negative and the positive battery cables from the battery terminals.

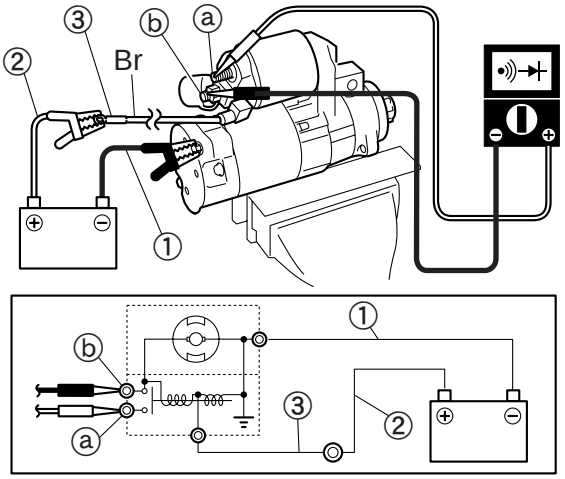
Checking the magnet switch

1. Connect the tester probes to the magnet switch terminals ⓐ and ⓑ.

2. Connect the negative battery cable ① to the starter motor body.

3. Connect the positive battery cable ② to the starter motor Brown (Br) lead ③, and then check the magnet switch continuity. ***NOTICE:*** **Do not connect the starter motor Brown (Br) lead to the battery for more than 1 second.**

4. Check that there is continuity between the magnet switch terminals ⓐ and ⓑ. Replace the magnet switch if out of specification.



Battery lead	Magnet switch terminal	
	ⓐ	ⓑ
Connect	○	○
Disconnect		

TIP:

The starter motor pinion should be pushed out while the magnet switch is “ON.”

Checking the starter motor pinion

⚠ WARNING

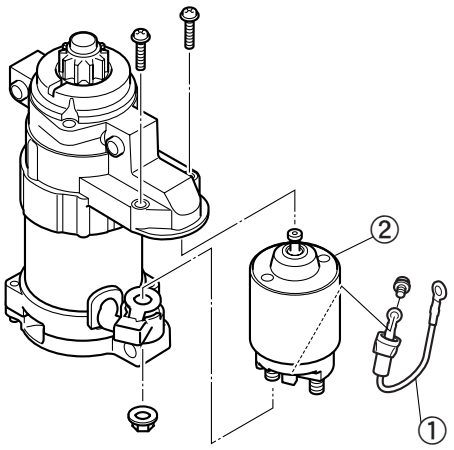
Make sure to disconnect the battery cables before checking the starter motor pinion.

1. Check the pinion teeth. Replace the pinion if cracked or worn.

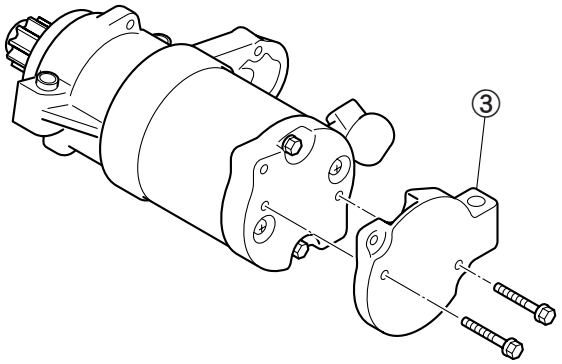
2. Check for smooth operation. Turn the pinion counterclockwise to check that it operates smoothly and turn it clockwise to check that it locks in place.

Disassembling the starter motor

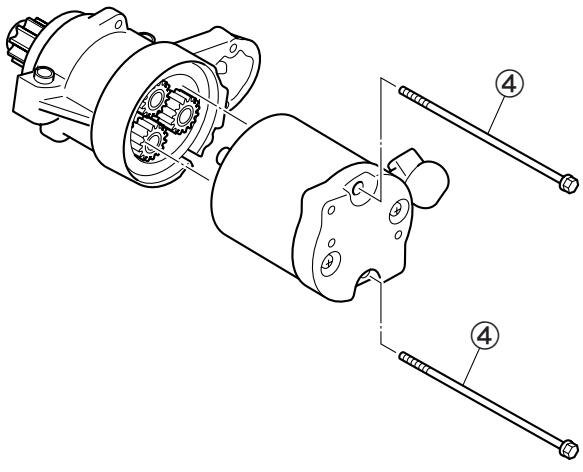
1. Remove the starter motor lead ① and the magnet switch ②.



2. Remove the bracket ③.

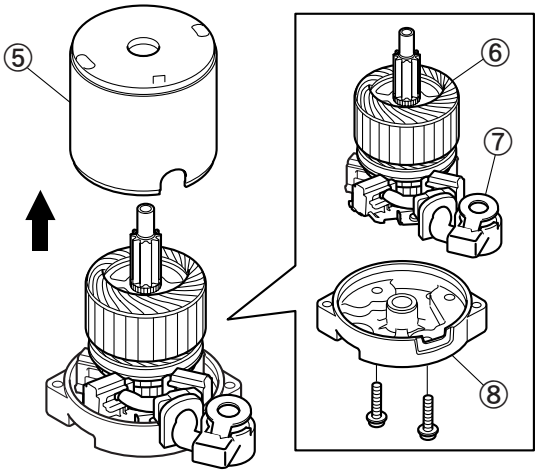


3. Remove the bolts ④, and then disassemble the starter motor.

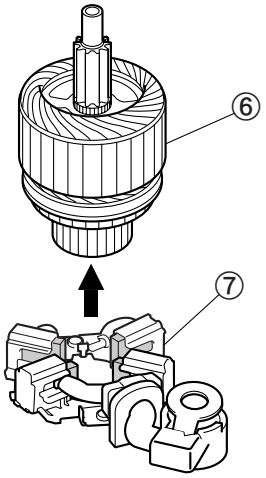


4. Remove the stator ⑤.

5. Remove the armature ⑥ together with the brush holder assembly ⑦ from the bracket ⑧.



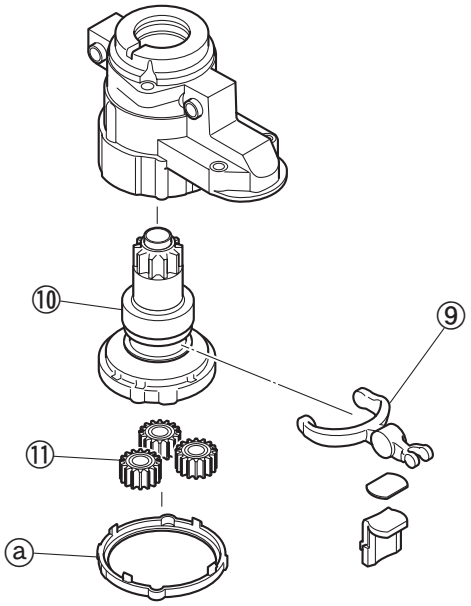
6. Remove the armature ⑥ from the brush holder assembly ⑦.



5

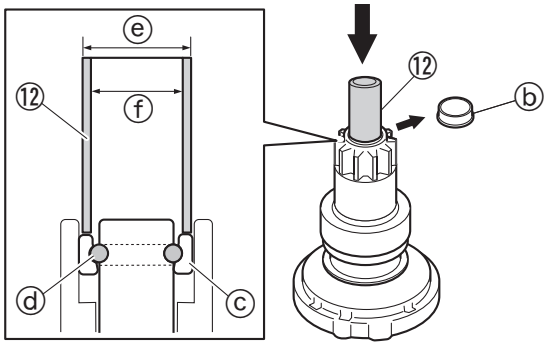
7. Remove the lever ⑨ and the pinion shaft assembly ⑩.

8. Remove the rubber seal ⓐ and the planetary gear ⑪.



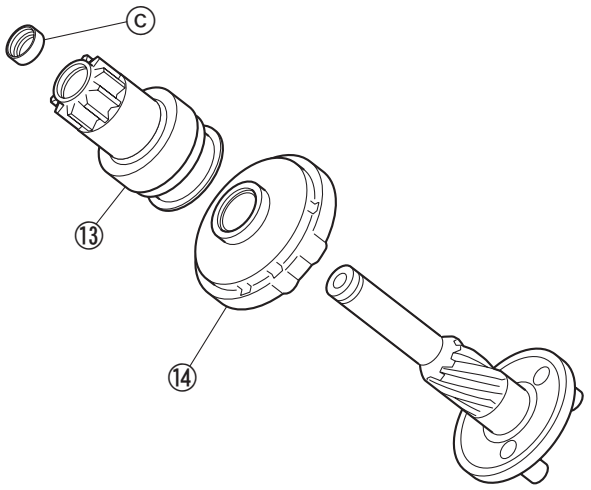
9. Remove the cap ⓑ.

10. Push down the pinion stopper ⓒ using a pipe ⑫, and then remove the clip ⓓ.



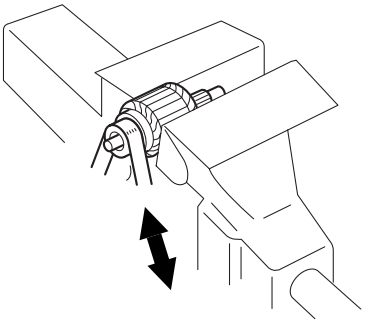
Pipe ⑫ (commercially available): ⓔ: 15.5 mm (0.61 in) ⓕ: 11.0 mm (0.43 in)

11. Remove the pinion stopper ⓒ, clutch assembly ⑬, and the outer gear ⑭.

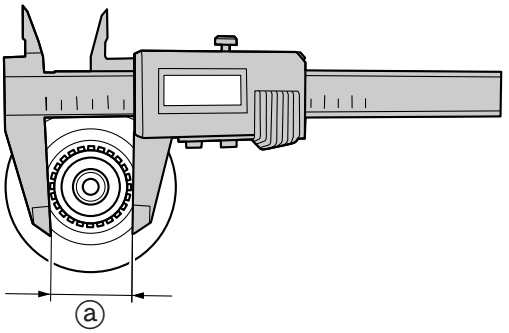


Checking the starter motor

1. Check the commutator. Clean with 600–grit sandpaper and compressed air if dirty.

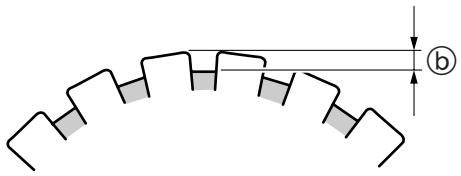


2. Measure the commutator diameter ⓐ. Replace the armature if below specification.



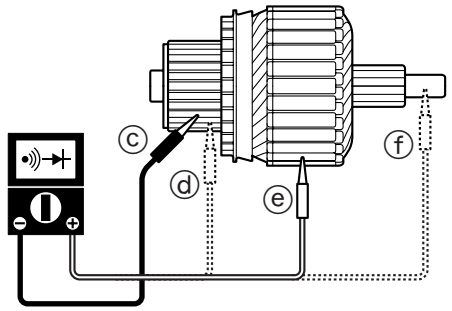
Commutator standard diameter ⓐ: 29.4 mm (1.16 in) Wear limit: 28.8 mm (1.13 in)

3. Measure the commutator undercut ⓑ. Replace the armature if below specification.



Commutator standard undercut ⓑ: 0.5 mm (0.02 in) Wear limit: 0.2 mm (0.01 in)

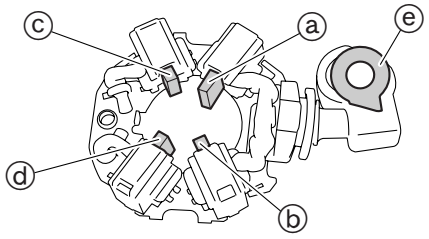
4. Check the armature for continuity. Replace if out of specification.

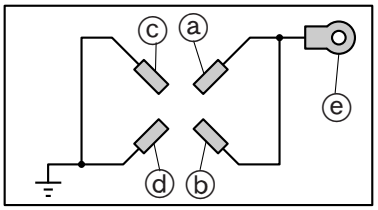


Armature continuity:			
ⓒ	ⓓ	ⓔ	ⓕ
○—○			

Checking the brush

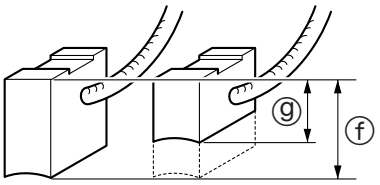
1. Check the brush holder assembly for continuity. Replace the brush holder assembly if out of specification.





Brush holder assembly continuity:				
ⓐ	ⓑ	ⓒ	ⓓ	ⓔ
○—○				
○—				—○
	○—			—○
		○—	—○	

2. Measure the length of each brush. Replace the brush assembly if below specification.



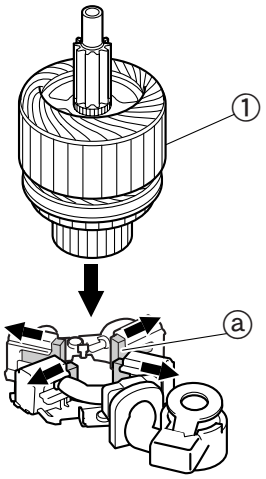
Brush standard length ⓕ: 12.3 mm (0.48 in) Wear limit ⓖ: 5.5 mm (0.22 in)

Assembling the starter motor

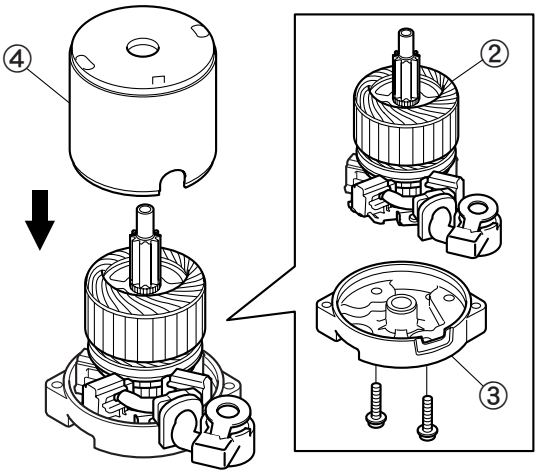
NOTICE

Do not allow grease or oil to contact the armature commutator.

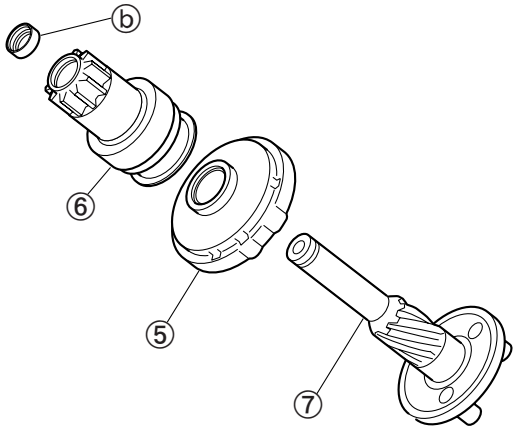
1. Push the brushes ⓐ into the holders, and then install the armature ① to the brush holder assembly.



2. Install the armature assembly ② to the bracket ③, and then install the stator ④.

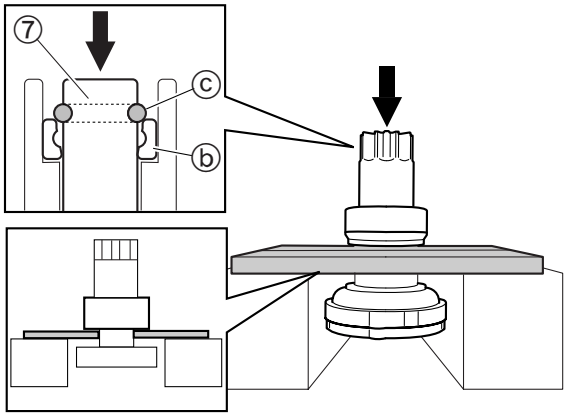


3. Install the outer gear ⑤, the clutch assembly ⑥, and the stopper ⓑ onto the pinion shaft ⑦.

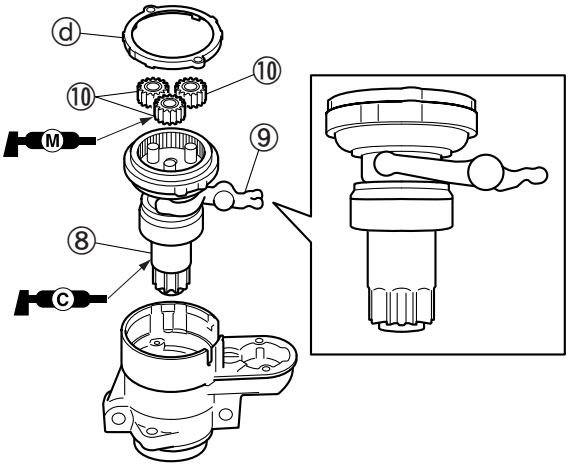


4. Install the clip ⓒ into the pinion shaft groove.

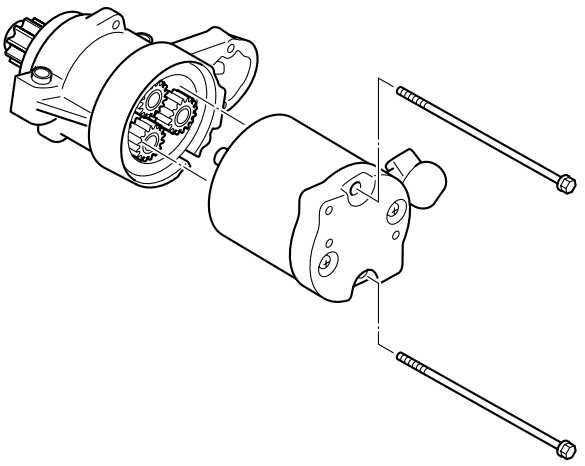
5. Install the clip ⓒ into the groove on the stopper ⓑ by tapping the pinion shaft ⑦.



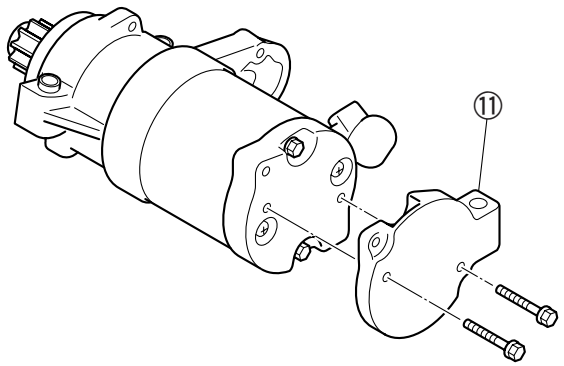
6. Install the pinion shaft assembly ⑧, the lever ⑨, the planetary gears ⑩, and the rubber seal ⓓ.



7. Assemble the starter motor.

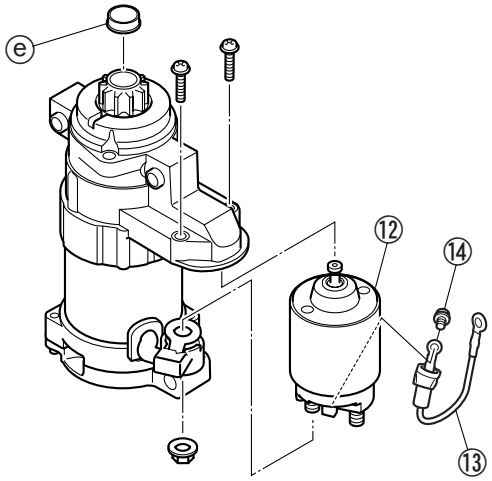


8. Install the bracket ⑪.



9. Install the magnet switch ⑫, cap ⓔ, and the starter motor lead ⑬.

10. Tighten the starter motor lead screw ⑭ to the specified torque.



Starter motor lead screw ⑭:
3 N·m (0.3 kgf·m, 2.2 ft·lb)

TIP:
Check the starter motor operation before installing it to the power unit. See “Checking the starter motor operation” (5-35).

Installing the starter motor

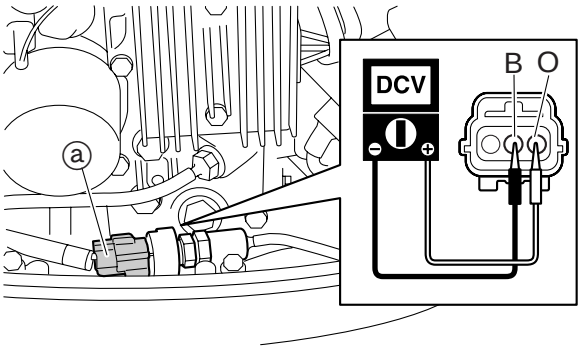
1. Install the starter motor to the power unit. See “Installing the starter motor” (7-29).

6Y8 Multifunction Meter sensor

Checking the water pressure sensor (option)

1. Disconnect the water pressure sensor coupler ⓐ.

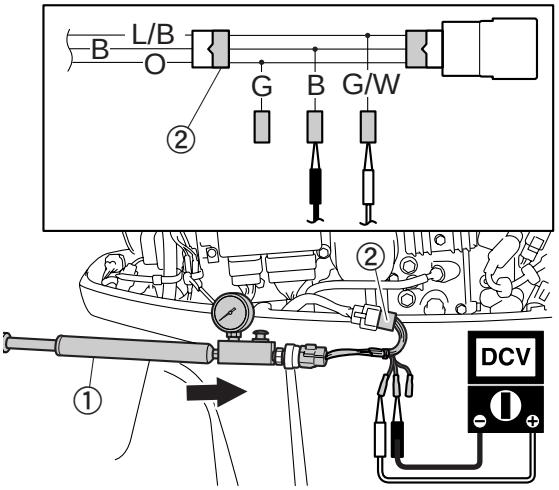
2. Turn the engine start switch to “ON,” and then measure the input voltage at the water pressure sensor coupler.



Water pressure sensor input voltage:
Orange (O)–Black (B)
4.75–5.25 V

3. Remove the water pressure sensor, and then connect the pressure pump ① and the test harness (3 pins) ②.

4. Apply positive pressure to the water pressure sensor slowly, and then measure the output voltage.



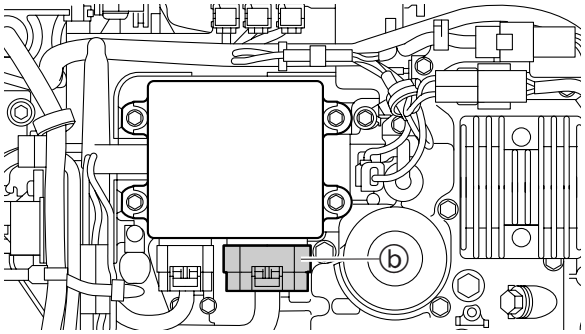
Pressure pump ①:
(commercially available)
Test harness (3 pins) ②: 90890-06869

5

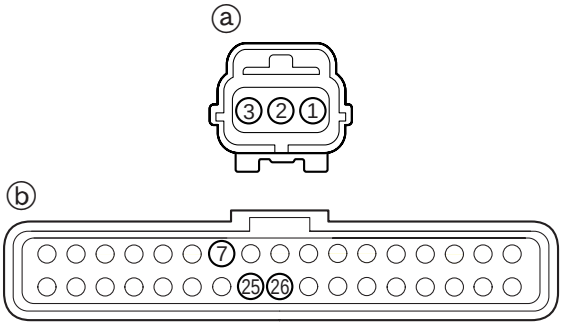
Water pressure sensor output voltage (reference data):
Blue/Black (L/B)–Black (B)
2.5 V at 392.0 kPa
(3.92 kgf/cm², 56.8 psi)
4.5 V at 784.0 kPa
(7.84 kgf/cm², 113.7 psi)

5. Turn the engine start switch to “OFF,” and then disconnect the test harness ② and the pressure pump ①.

6. Disconnect the engine ECM coupler ⓑ.



7. Check the wiring harness for continuity.



Wiring harness continuity:
Terminal 1–Terminal 7
Terminal 2–Terminal 26
Terminal 3–Terminal 25

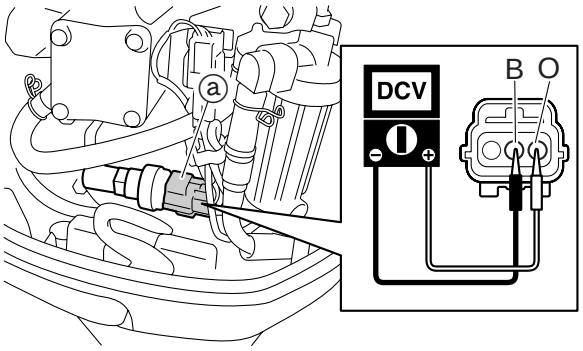
8. Install the water pressure sensor, and then connect the water pressure sensor coupler ⓐ. See “Installing the water pressure sensor” (3-16).

9. Connect the engine ECM coupler ⓑ.

Checking the speed sensor (option)

1. Disconnect the speed sensor coupler ⓐ.

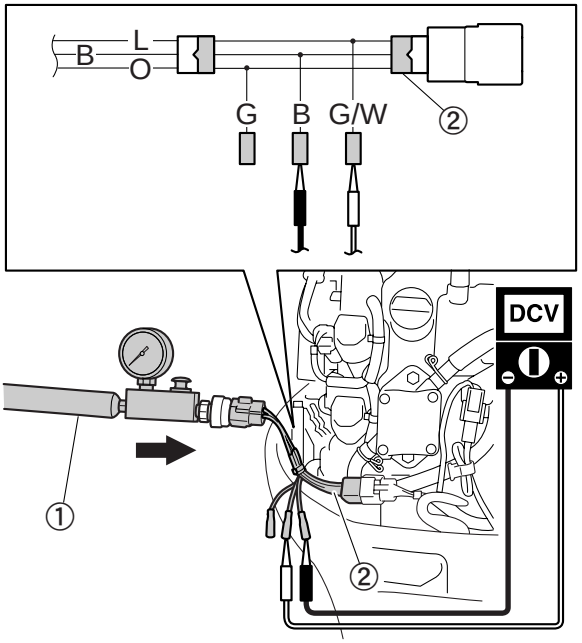
2. Turn the engine start switch to “ON,” and then measure the input voltage at the speed sensor coupler.



Speed sensor input voltage:
Orange (O)–Black (B)
4.75–5.25 V

3. Remove the speed sensor, and then connect the pressure pump ① and the test harness (3 pins) ②.

4. Apply positive pressure to the speed sensor slowly, and then measure the output voltage.

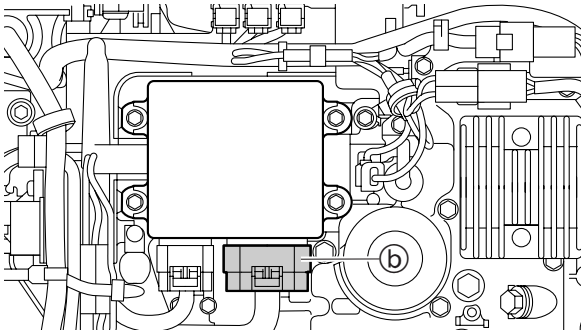


Pressure pump ①:
(commercially available)
Test harness (3 pins) ②: 90890-06869

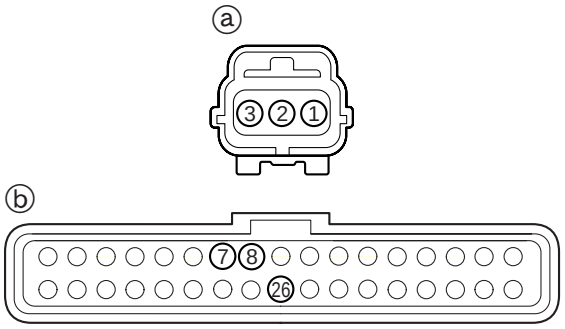
Speed sensor output voltage
(reference data):
Blue (L)–Black (B)
2.5 V at 392.0 kPa
(3.92 kgf/cm², 56.8 psi)
4.5 V at 784.0 kPa
(7.84 kgf/cm², 113.7 psi)

5. Turn the engine start switch to "OFF," and then disconnect the test harness ② and the pressure pump ①.

6. Disconnect the engine ECM coupler ⓑ.



7. Check the wiring harness for continuity.



Wiring harness continuity:
Terminal 1–Terminal 7
Terminal 2–Terminal 26
Terminal 3–Terminal 8

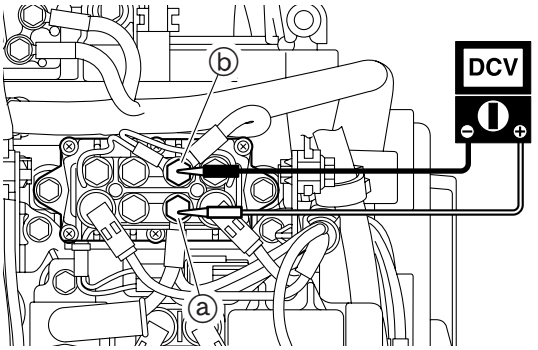
8. Install the speed sensor, and then connect the speed sensor coupler ⓐ. See "Installing the speed sensor" (3-17).

9. Connect the engine ECM coupler ⓑ.

PTT electrical system

Checking the PTT relay

1. Measure the input voltage between the PTT relay terminal ⓐ and the terminal ⓑ.

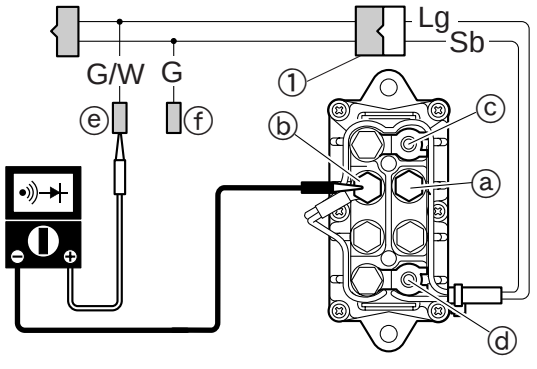


PTT relay input voltage:
Terminal ⓐ–Terminal ⓑ
12.0 V (battery voltage)

2. Disconnect the battery power source, the ground lead, the PTT motor leads and the PTT relay coupler. ***NOTICE:*** **Always disconnect the battery negative terminal before disconnecting the PTT relay terminals.**

3. Connect the test harness (2 pins) ①.

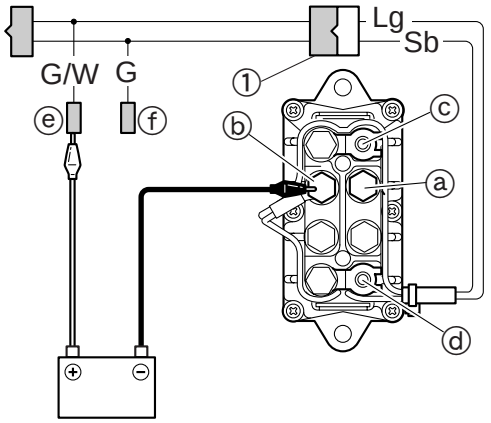
4. Check the PTT relay for continuity. Replace if out of specification.



Test harness (2 pins) ①: 90890-06867

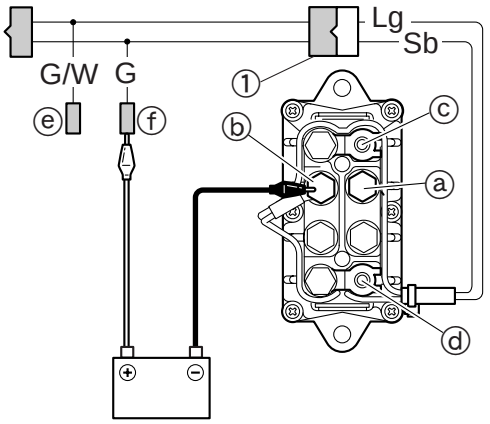
PTT relay continuity:					
ⓐ	ⓑ	ⓒ	ⓓ	ⓔ	ⓕ
	○—○				
	○—	—	○		
	○—	—	—	○	
	○—	—	—	—	○

5. Connect the positive battery lead to the terminal ⓔ, and the negative battery lead to the terminal ⓑ, and then check the PTT relay for continuity. Replace the PTT relay if out of specification.



PTT relay continuity:			
ⓐ	ⓑ	ⓒ	ⓓ
○—	—	—	○
	○—	—	—

6. Connect the positive battery lead to the terminal ⓕ, and the negative battery lead to the terminal ⓑ, and then check the PTT relay for continuity. Replace the PTT relay if out of specification.

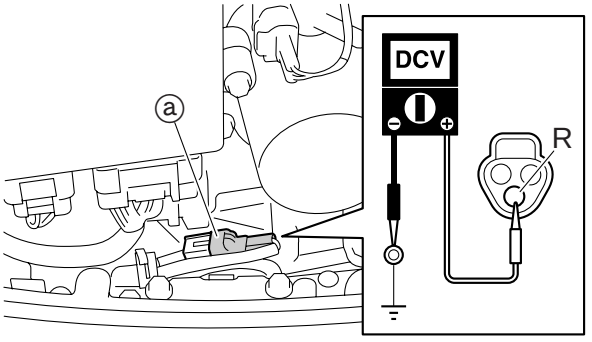


PTT relay continuity:			
ⓐ	ⓑ	ⓒ	ⓓ
○—	—	○	
	○—	—	○

7. Connect the PTT relay coupler, the battery power source, the ground lead, and the PTT motor leads.

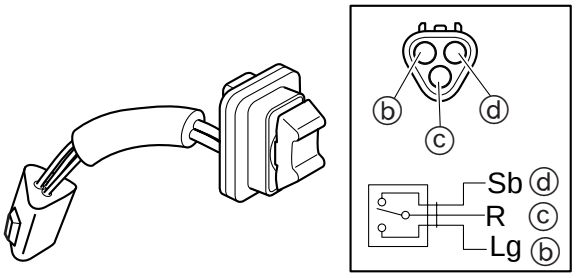
Checking the PTT switch (on bottom cowling)

1. Disconnect the PTT switch coupler ⓐ.
2. Measure the input voltage between the PTT switch coupler terminal and the ground.



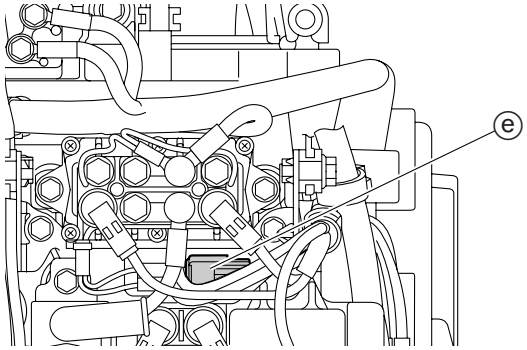
PTT switch input voltage:
Red (R)–Ground
12.0 V (battery voltage)

3. Check the PTT switch for continuity. Replace the PTT switch if out of specification.

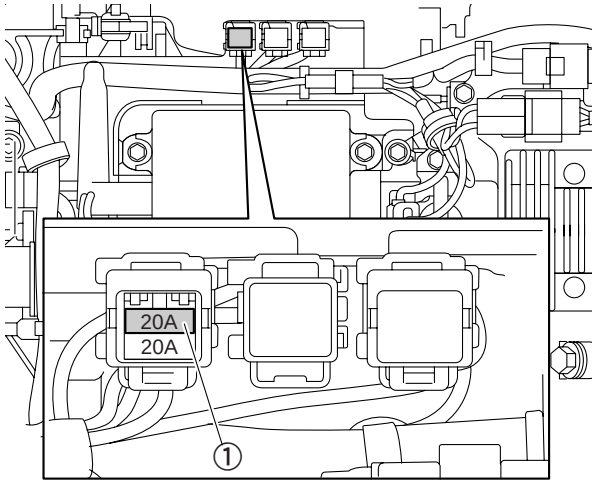


Switch position	Terminal		
	ⓑ	ⓒ	ⓓ
UP		○——○	
Free			
DN	○——○		

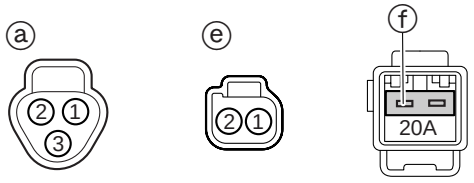
4. Disconnect the PTT relay coupler ⓔ.



5. Remove the fuse ①.



6. Check the wiring harness for continuity.



Wiring harness continuity:
ⓐ Terminal 1–ⓔ Terminal 1 ⓐ Terminal 2–ⓔ Terminal 2 ⓐ Terminal 3–Terminal ⓕ

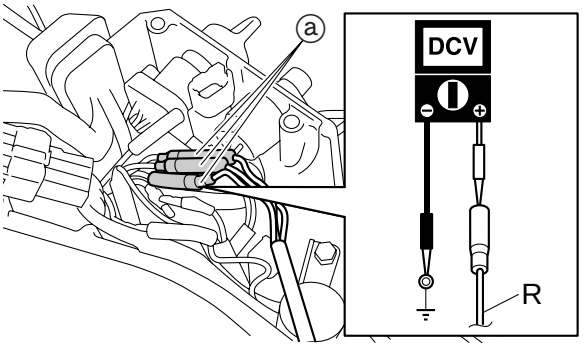
7. Connect the PTT relay coupler ⓔ and the PTT switch coupler ⓐ.

8. Install the fuse ①.

Checking the PTT switch (tiller handle model)

1. Disconnect the PTT switch connectors ⓐ.

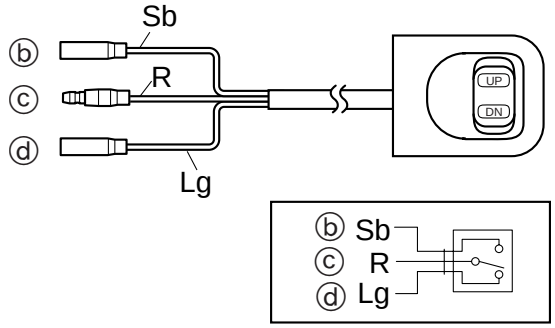
2. Measure the input voltage between the PTT switch connector and the ground.



PTT switch input voltage: Red (R)–Ground 12.0 V (battery voltage)

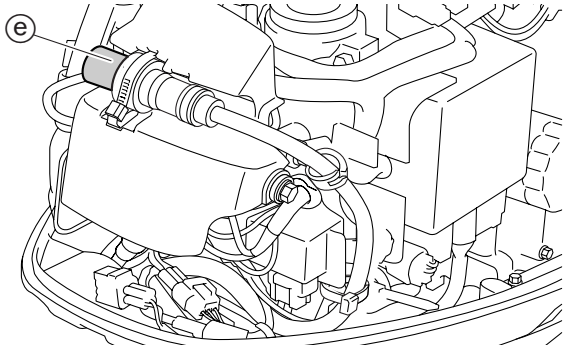
3. Check the PTT switch for continuity. Replace if out of specification.

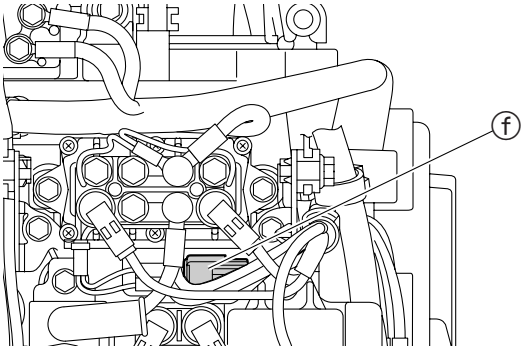
5



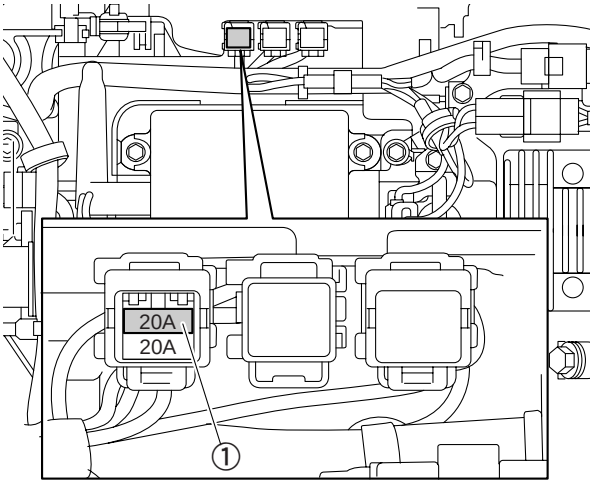
Switch position	Terminal		
	ⓑ	ⓒ	ⓓ
UP	O	O	
Free			
DN		O	O

4. Disconnect the 10-pin coupler ⓔ and the PTT relay coupler ⓕ.

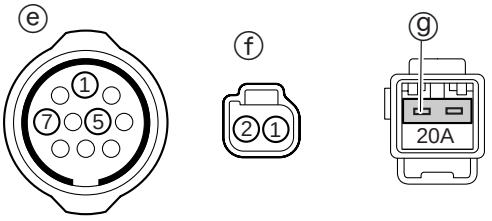




5. Remove the fuse ①.



6. Check the wiring harness for continuity.



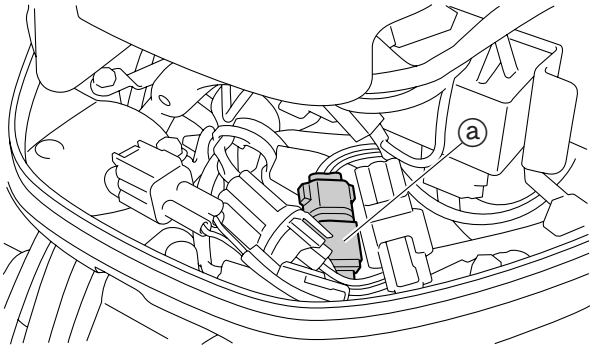
Wiring harness continuity:
ⓔ Terminal 1–Terminal ⓖ
ⓔ Terminal 5–ⓕ Terminal 2
ⓔ Terminal 7–ⓕ Terminal 1

7. Connect the PTT relay coupler ⓕ, the 10-pin coupler ⓔ, and the PTT switch connectors ⓐ.

8. Install the fuse ①.

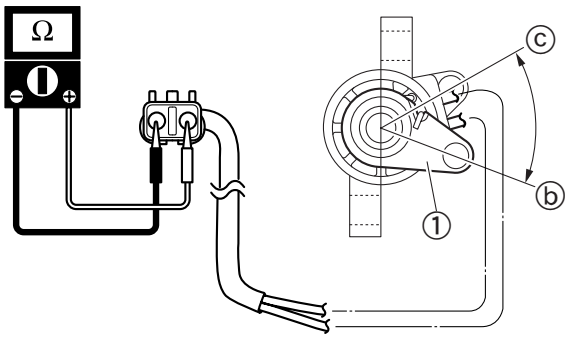
Checking the trim sensor

1. Disconnect the trim sensor coupler ⓐ, and then remove the trim sensor.



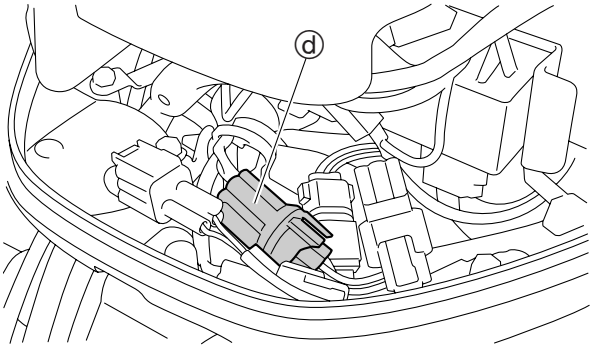
2. Measure the trim sensor resistance.

3. Turn the trim sensor lever ① from the position ⓑ to the position ⓒ, and then measure the resistance as it gradually changes.

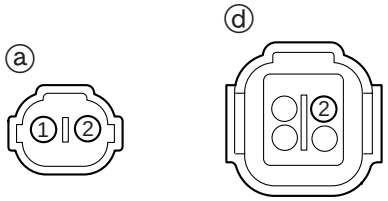


Trim sensor resistance (reference data):
238.8–378.8 Ω at ⓑ
9.0–11.0 Ω at ⓒ (setting resistance)

4. Disconnect the alert indicator harness coupler ⓓ.



5. Check the wiring harness for continuity.



Wiring harness continuity:
ⓐ Terminal 1–ⓓ Terminal 2
ⓐ Terminal 2–Ground

6. Install the trim sensor.

7. Connect the gauge harness coupler ⓓ and the trim sensor coupler ⓐ.

5

Fuel system

Hose routing 6-1
Fuel hose 6-1
Vapor gas hose 6-2
Cooling water hose 6-3

Fuel line 6-4
Reducing the fuel pressure 6-4
Disconnecting the quick connector 6-4
Measuring the fuel pressure 6-4
Checking the pressure regulator 6-5

Fuel filter assembly 6-7
Removing the fuel filter assembly 6-9
Checking the fuel joint 6-9
Checking the fuel filter assembly 6-9
Disassembling the fuel filter assembly 6-10
Checking the fuel filter element 6-10
Checking the fuel cup assembly 6-10
Assemble the fuel filter assembly 6-11
Installing the fuel filter assembly 6-11

Fuel pump assembly 6-12
Removing the fuel pump assembly 6-13
Checking the fuel pump assembly 6-13
Disassembling the fuel pump assembly 6-13
Checking the diaphragm and valve 6-14
Assembling the fuel pump assembly 6-15
Installing the fuel pump assembly 6-15
Checking the primer pump 6-16

Throttle body 6-17
Removing the throttle body 6-18
Checking the intake manifold 6-19
Checking the throttle body 6-19
Installing the throttle body 6-19

Throttle link rod 6-21
Removing the throttle link 6-22
Installing the throttle link 6-22
Adjusting the throttle link rod 6-23

Vapor separator 6-25
Draining the fuel 6-26
Removing the fuel hose clamp 6-26
Installing the fuel hose clamp 6-26
Removing the vapor separator 6-26

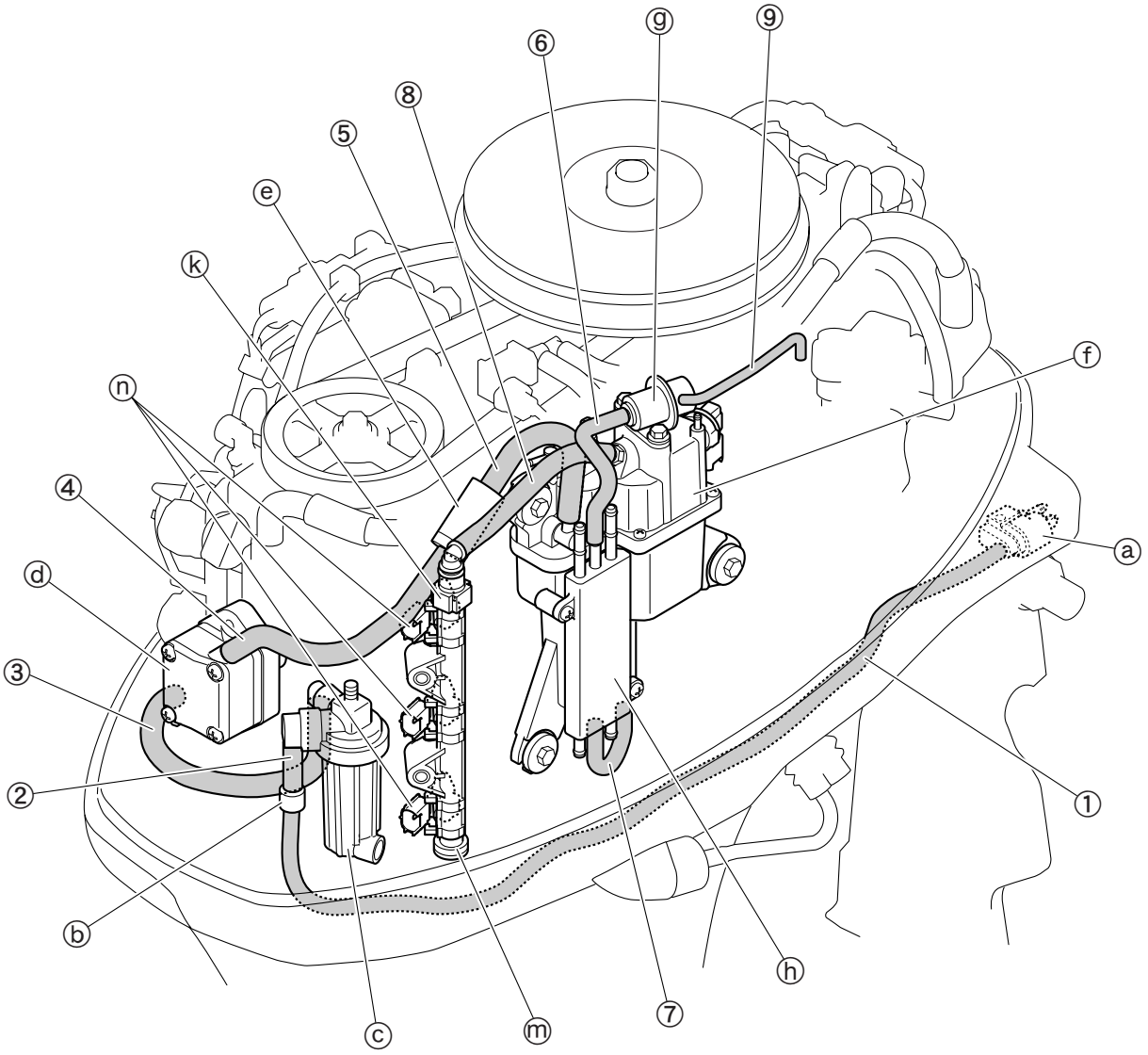
Checking the vapor shut-off valve 6-27
Installing the vapor separator 6-27

Vapor separator (disassembly) 6-29
Disassembling the vapor separator 6-32
Checking the fuel strainer 6-33
Checking the high-pressure fuel pump 6-33
Checking the vapor separator 6-33
Adjusting the float height 6-34
Assembling the vapor separator 6-34

Fuel injector 6-38
Removing the fuel injector 6-39
Checking the fuel rail 6-39
Installing the fuel injector 6-39

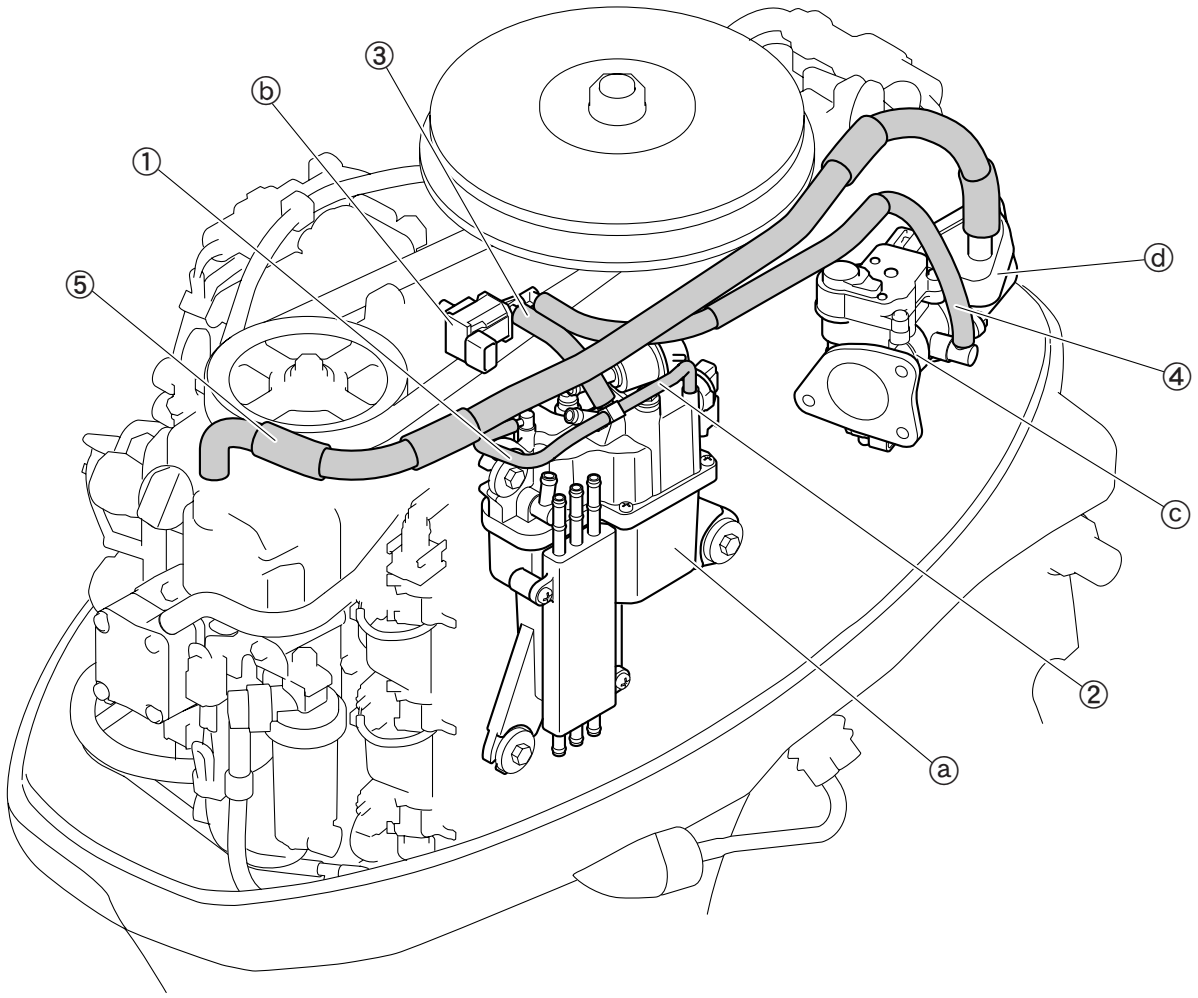
Hose routing

Fuel hose



① Fuel hose (fuel joint-to-joint)
② Fuel hose (joint-to-fuel filter)
③ Fuel hose (fuel filter-to-fuel pump)
④ Fuel hose (fuel pump-to-strainer)
⑤ Fuel hose (strainer-to-vapor separator)
⑥ Fuel hose (pressure regulator-to-fuel cooler)
⑦ Fuel hose (fuel cooler-to-vapor separator)
⑧ Fuel hose (vapor separator-to-quick connector)
⑨ Pressure regulator hose (pressure regulator-to-intake manifold)
ⓐ Fuel joint
ⓑ Joint
ⓒ Fuel filter
ⓓ Fuel pump
ⓔ Strainer
ⓕ Vapor separator
ⓖ Pressure regulator
ⓗ Fuel cooler
ⓚ Quick connector
ⓜ Fuel rail
ⓝ Fuel injector

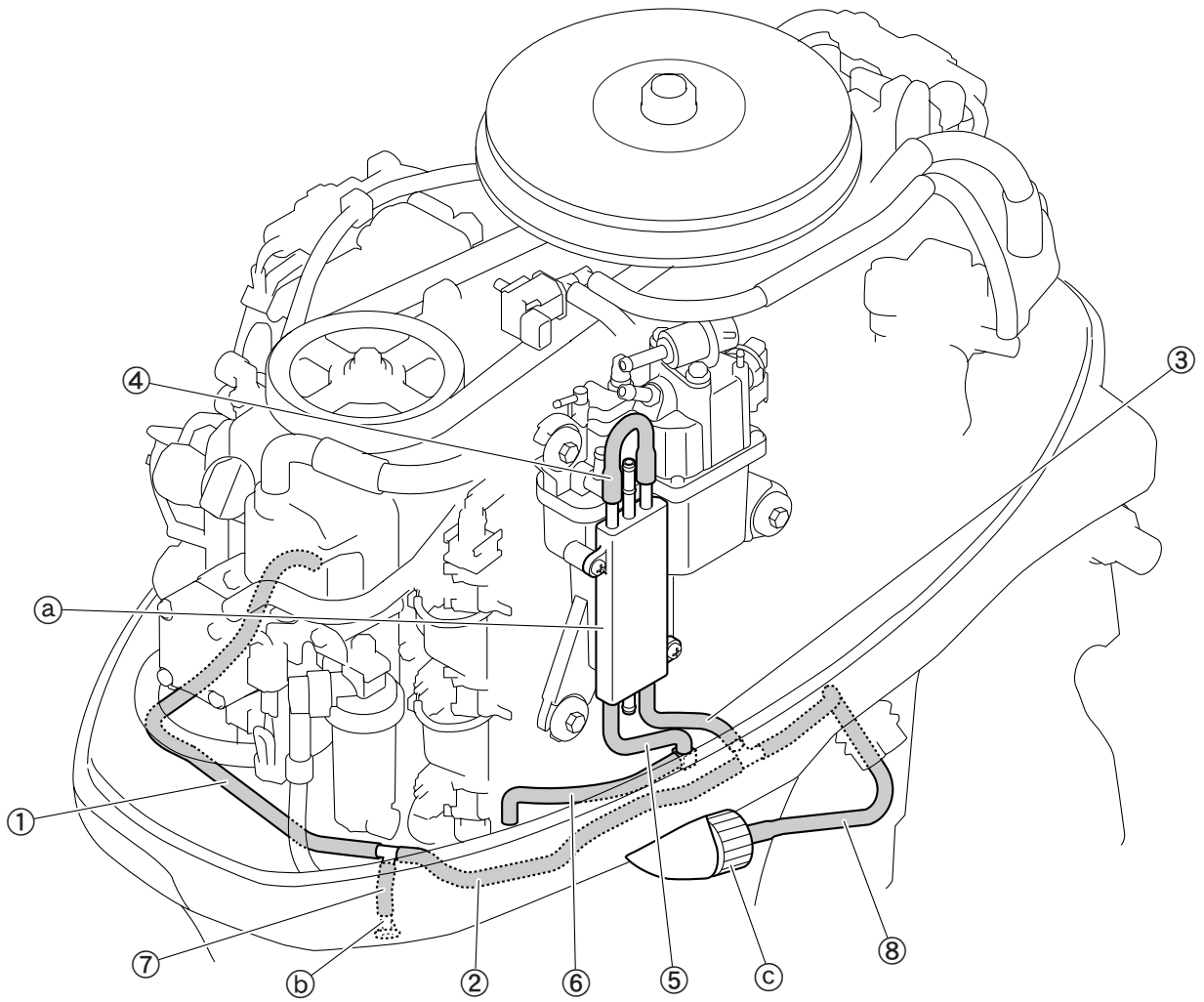
Vapor gas hose



① Vapor gas hose (vapor separator-to-joint)
② Vapor gas hose (vapor separator-to-joint)
③ Vapor gas hose (joint-to-vapor shut-off valve)
④ Vapor gas hose (vapor shut-off valve-to-throttle body)
⑤ Blowby hose (cylinder head cover-to-intake silencer)

ⓐ Vapor separator
ⓑ Vapor shut-off valve
ⓒ Throttle body
ⓓ Intake silencer

Cooling water hose



① Cooling water hose (exhaust cover-to-joint)
② Cooling water hose (joint-to-joint)
③ Cooling water pilot hose (joint-to-fuel cooler)
④ Cooling water hose (fuel cooler-to-fuel cooler)
⑤ Cooling water hose (fuel cooler-to-joint)
⑥ Cooling water hose (joint-to-exhaust guide)
⑦ Cooling water hose (joint-to-cooling water outlet)
⑧ Flushing hose (flushing hose adapter-to-joint)

ⓐ Fuel cooler
ⓑ Cooling water outlet (on the bottom cowling)
ⓒ Flushing hose adapter

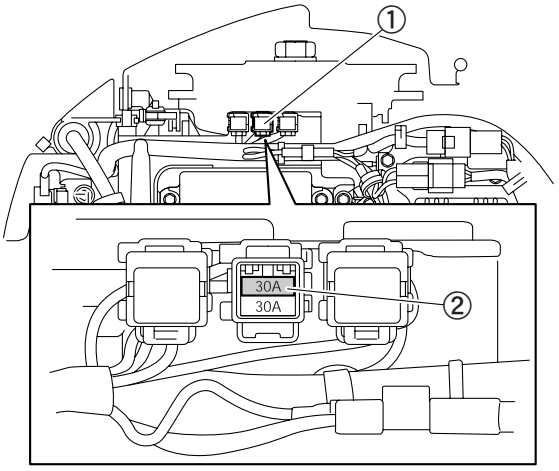
Fuel line

Reducing the fuel pressure

⚠ WARNING

Always reduce the fuel pressure in the high-pressure fuel line before servicing the line or the vapor separator. If the fuel pressure is not released, pressurized fuel may spray out.

1. Start the engine.
2. Remove the fuse holder cover ①, and then remove the main fuse (30 A) ②.



TIP:

After removing the fuse, wait until the engine stalls.

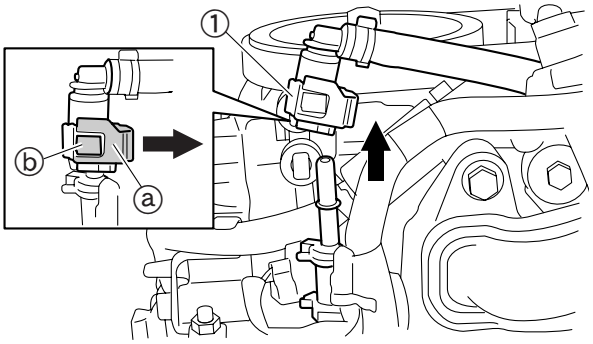
3. After the engine stalls, crank the engine 2 or 3 times.
4. Turn the engine start switch to "OFF."
5. Install the main fuse (30 A) ②, and then install the fuse holder cover ①.

Disconnecting the quick connector

⚠ WARNING

If the quick connector is disconnected suddenly, pressurized fuel could spray out. Make sure to reduce the fuel pressure before disconnecting the quick connector.

1. Reduce the fuel pressure.
2. Release the lock by pulling ⓐ, and disconnect the quick connector by pressing both sides of ⓑ.
3. Disconnect the quick connector ① from the fuel rail.

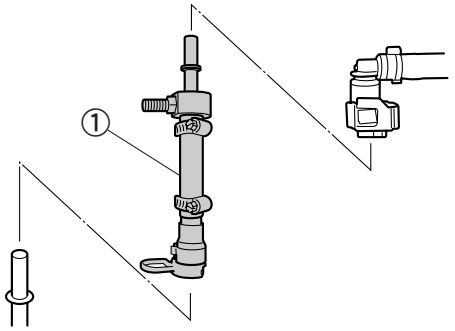


TIP:

- Cover the quick connector with a rag to catch any spilled fuel when disconnecting it.
- Cover the quick connector and the fuel rail with a plastic bag to prevent damage and protect them from dirt.

Measuring the fuel pressure

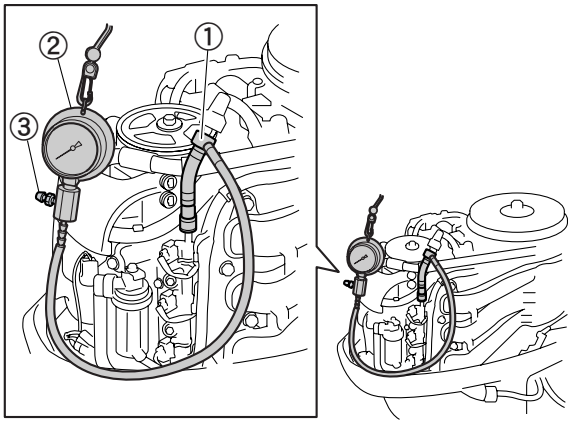
1. Reduce the fuel pressure.
2. Disconnect the quick connector.
3. Connect the special service tool ① between the quick connector and the fuel rail.



Fuel pressure gauge adapter ①: 90890-06842

6

4. Connect the special service tool ②. **WARNING! Gently screw in the gauge until it is firmly connected to prevent fuel from leaking out. Also, make sure that the drain screw ③ is tightened securely, before measuring the fuel pressure.**



Fuel pressure gauge ②: 90890-06786

5. Turn the engine start switch to "ON," and then measure the fuel pressure within 3 seconds.

Fuel pressure (reference data):
280.0 kPa (2.80 kgf/cm², 40.6 psi)

TIP:
The fuel pressure decreases 3 seconds after the engine start switch is turned to "ON."

6. Start the engine and warm it up until the idle speed gets stable at 750–850 r/min.

7. Measure the fuel pressure. Check the vapor separator if below specification.

Fuel pressure (reference data):
230.0 kPa (2.30 kgf/cm², 33.4 psi)
at engine idle speed

8. Turn the engine start switch to "OFF."

9. Reduce the fuel pressure. See "Reducing the fuel pressure" (6-4).

10. Disconnect the special service tools ① and ②. **WARNING! Before disconnecting the special service tools ① and ②, cover the end of the hose with a clean and dry rag.**

11. Connect the quick connector to the fuel rail.

12. After measuring the fuel pressure, cover the end of the hose with a clean and dry rag with the hose end pointing down. And then loosen the drain screw ③ to drain the remaining fuel from the hose and the gauge. **WARNING! When storing the fuel pressure gauge, make sure that the drain screw ③ is tightened securely.**

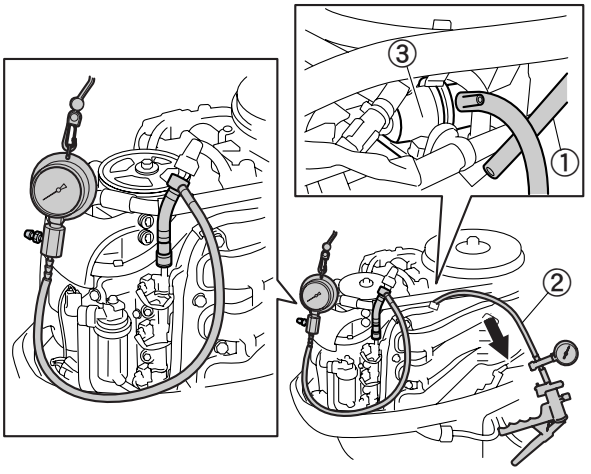
Checking the pressure regulator

1. Reduce the fuel pressure. See "Reducing the fuel pressure" (6-4).

2. Disconnect the quick connector. See "Disconnecting the quick connector" (6-4).

3. Connect the special service tools. See "Measuring the fuel pressure" (6-4) step 3 and step 4.

4. Disconnect the pressure regulator hose ①, and then connect the special service tool ② to the pressure regulator ③.



Vacuum/pressure pump gauge set ②:
90890-06756

5. Cover the pressure regulator hose end during the measurement.

6. Start the engine and let it idle.

7. Check that the fuel pressure is reduced when vacuum pressure is applied to the pressure regulator. If the fuel pressure is not reduced, replace the pressure regulator.

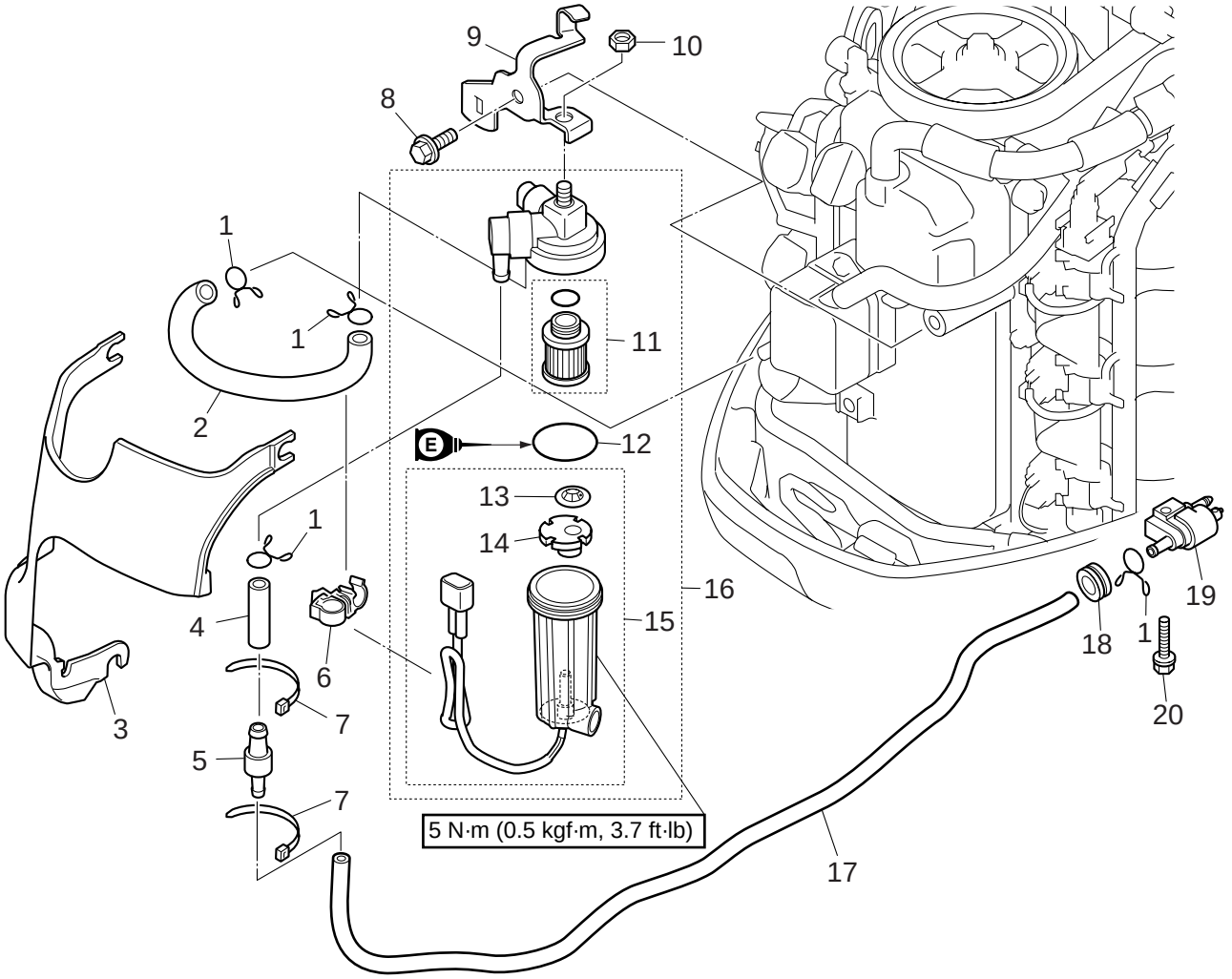
8. Turn the engine start switch to “OFF.”

9. Disconnect the special service tool ②, and then connect the pressure regulator hose ①.

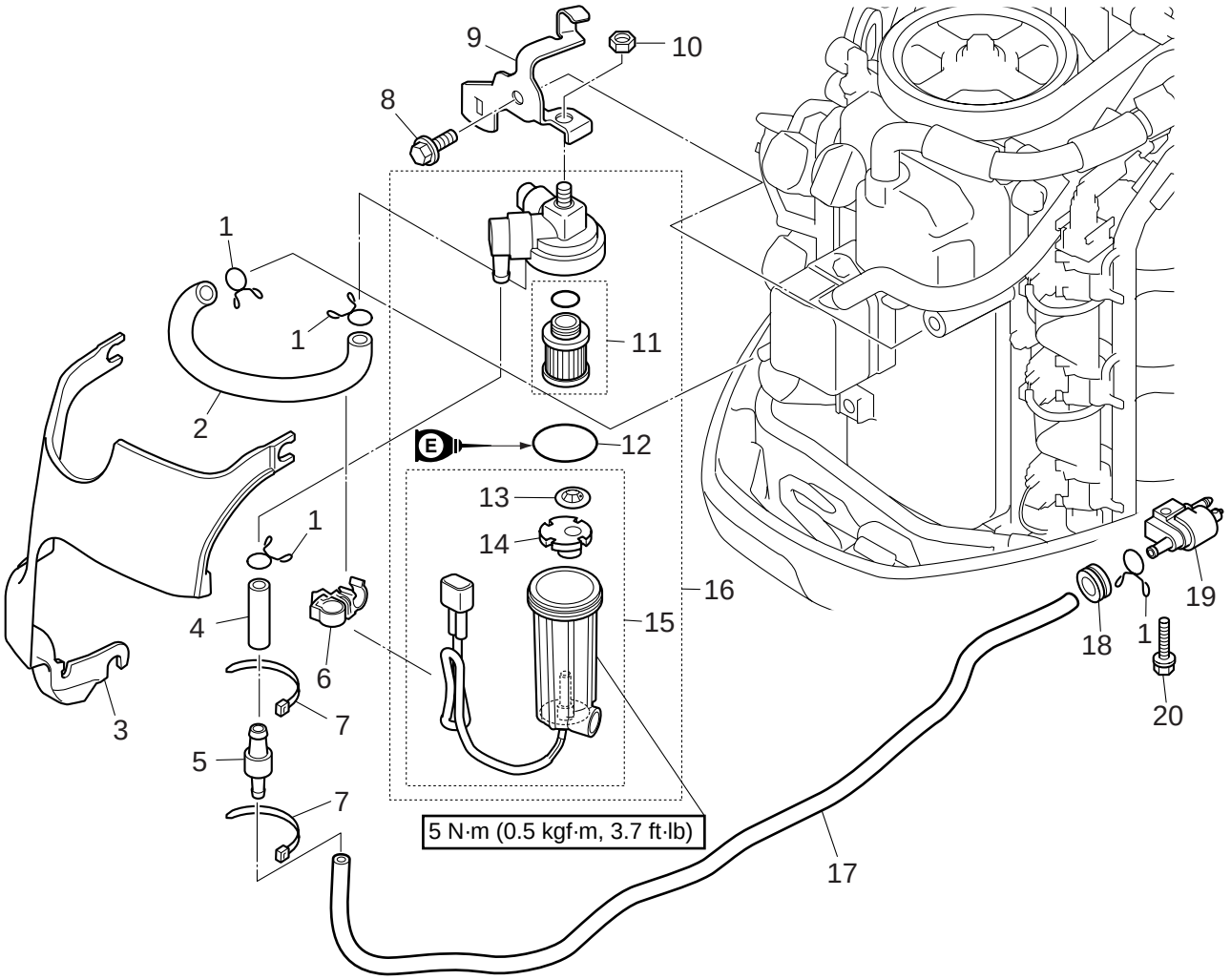
10. Reduce the fuel pressure. See “Reducing the fuel pressure” (6-4).

11. Disconnect the special service tools. See “Measuring the fuel pressure” (6-4) step 10–step 12.

Fuel filter assembly



No.	Part name	Q'ty	Remarks
1	Clip	4	
2	Hose	1	
3	Cover	1	
4	Hose	1	
5	Joint	1	
6	Clamp	1	
7	Plastic tie	2	**Not reusable**
8	Bolt	1	M8 × 20 mm
9	Bracket	1	
10	Nut	1	
11	Fuel filter element	1	
12	O-ring	1	**Not reusable**
13	Clip	1	
14	Float	1	
15	Fuel cup assembly	1	
16	Fuel filter assembly	1	
17	Hose	1	



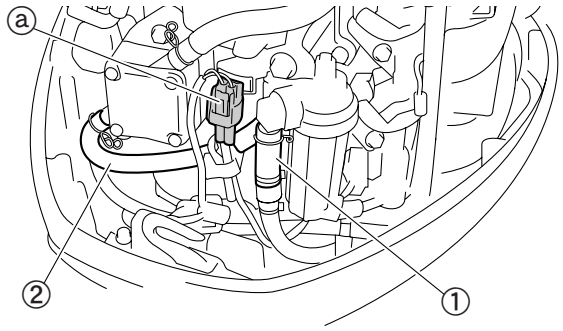
No.	Part name	Q'ty	Remarks
18	Grommet	1	
19	Fuel joint	1	
20	Bolt	1	M6 × 25 mm

Removing the fuel filter assembly

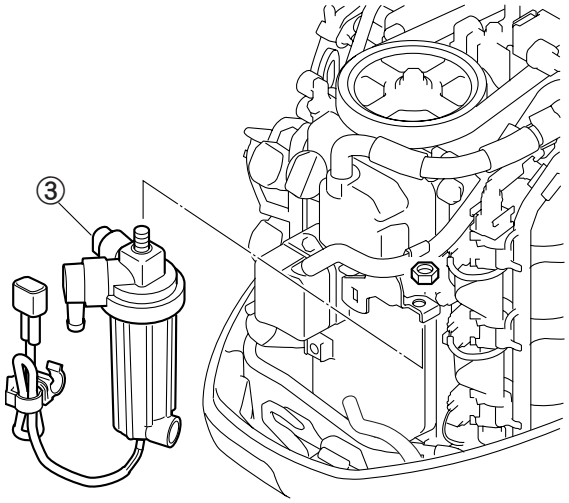
Use a rag to catch any spilled gasoline when removing the fuel components.

1. Disconnect the fuel hoses ① and ②.

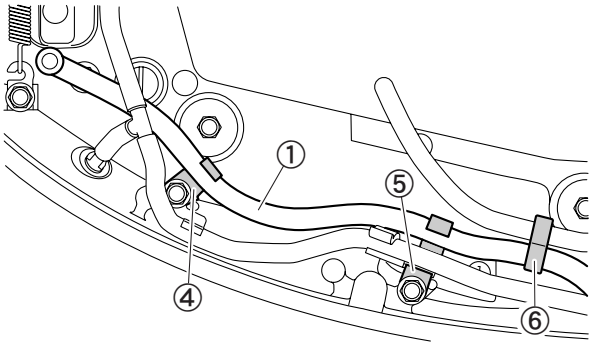
2. Disconnect the water detection switch coupler ⓐ.



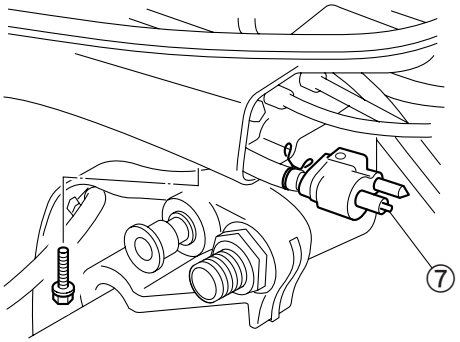
3. Remove the fuel filter assembly ③.



4. Remove the fuel hose ① from the clamps ④, ⑤ and ⑥.



5. Remove the fuel joint ⑦.

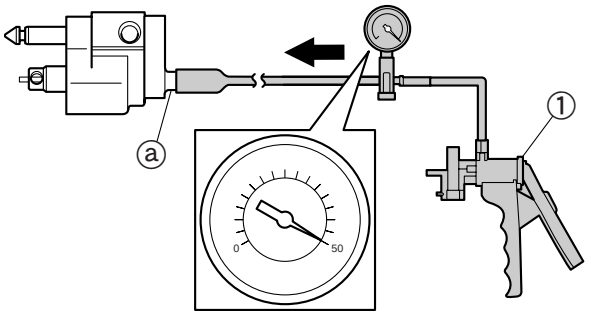


Checking the fuel joint

1. Check the fuel joint. Replace if cracked or damaged.

2. Connect the special service tool ① to the fuel joint outlet ⓐ.

3. Apply the specified positive pressure. Replace the fuel joint if the specified pressure cannot be maintained for at least 10 seconds.



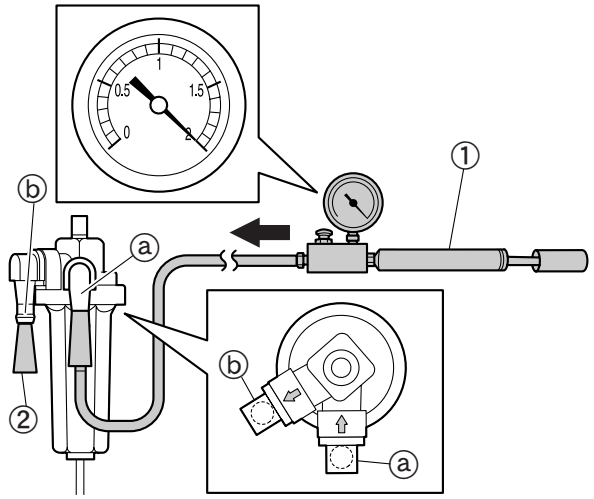
Vacuum/pressure pump gauge set ②:
90890-06756

Specified positive pressure:
50.0 kPa (0.50 kgf/cm², 7.3 psi)

Checking the fuel filter assembly

1. Connect the special service tool ① to the fuel inlet ⓐ.

2. Cover the fuel outlet ⓑ with a rubber plug ②, and then apply the specified positive pressure. Replace the O-ring, fuel cup assembly, or fuel filter assembly if the specified pressure cannot be maintained for at least 15 seconds.

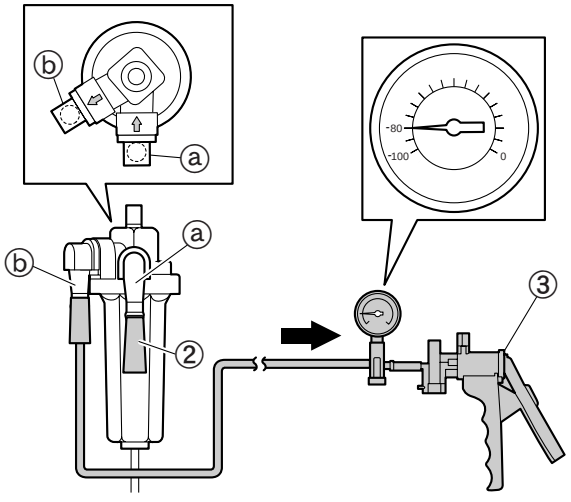


Leakage tester ①: 90890-06840

Specified positive pressure:
200.0 kPa (2.00 kgf/cm², 29.0 psi)

3. Connect the special service tool ③ to the fuel outlet ⓑ.

4. Cover the fuel inlet ⓐ with a rubber plug ②, and then apply the specified negative pressure. Replace the O-ring, the fuel cup assembly, or the fuel filter assembly if the specified pressure cannot be maintained for at least 15 seconds.

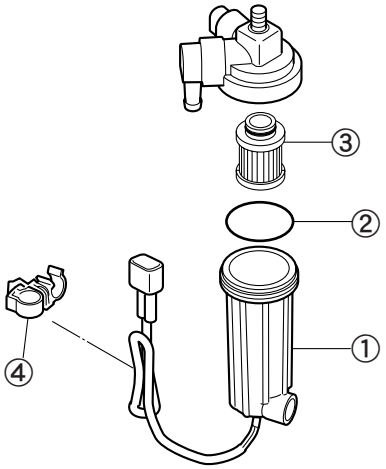


Vacuum/pressure pump gauge set ③:
90890-06756

Specified negative pressure:
80.0 kPa (0.80 kgf/cm², 11.6 psi)

Disassembling the fuel filter assembly

1. Remove the fuel cup assembly ①, the O-ring ②, the fuel filter element ③, and the clamp ④.



Checking the fuel filter element

1. Check the fuel filter element. Replace the fuel filter element if there is dirt or residues.

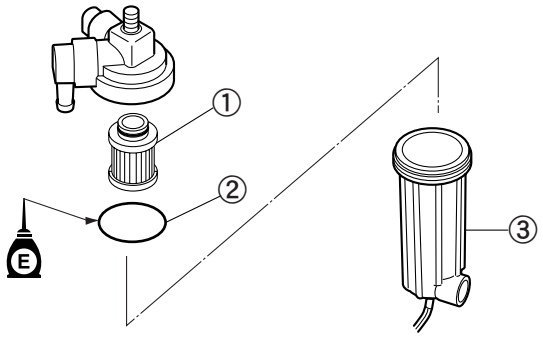
Checking the fuel cup assembly

1. Check the fuel cup assembly. Clean with straight gasoline if there are foreign substances or replace if cracked.
NOTICE: **When cleaning the fuel cup assembly, make sure not to remove the clip and float.**

2. Check the water detection switch. See “Checking the water detection switch” (5-20).

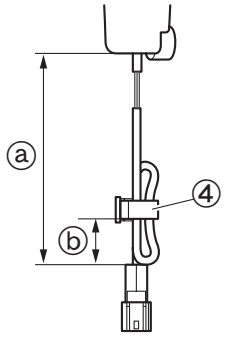
Assemble the fuel filter assembly

1. Install the fuel element ①, a new o-ring ②, and the fuel cup assembly ③, and then tighten the fuel cup assembly ③ to the specified torque.



Fuel cup assembly ③: 5 N·m (0.5 kgf·m, 3.7 ft·lb)

2. Install the clamp ④.

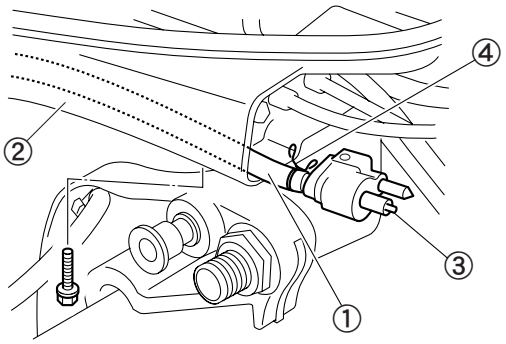


ⓐ: 115–125 mm (4.53–4.92 in) ⓑ: 20–30 mm (0.79–1.18 in)

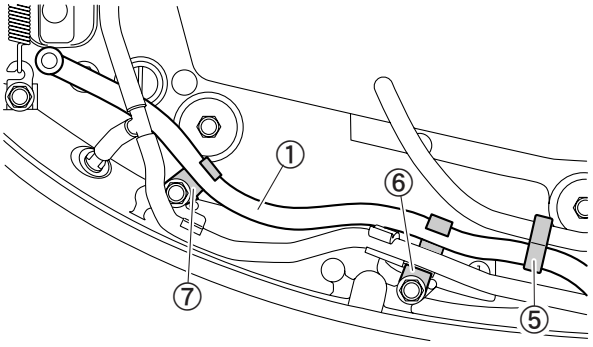
Installing the fuel filter assembly

1. Pass the fuel hose ① through the bottom cowling ②.

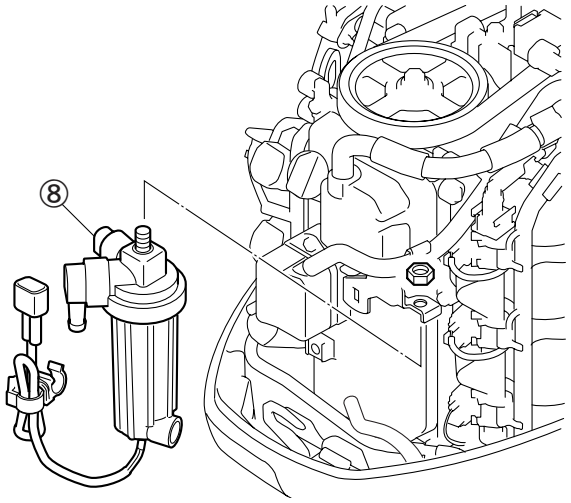
2. Install the hose ① to the fuel joint ③ with a clip ④, and then install the fuel joint.



3. Install the fuel hose ① to the clamps ⑤, ⑥, and ⑦.

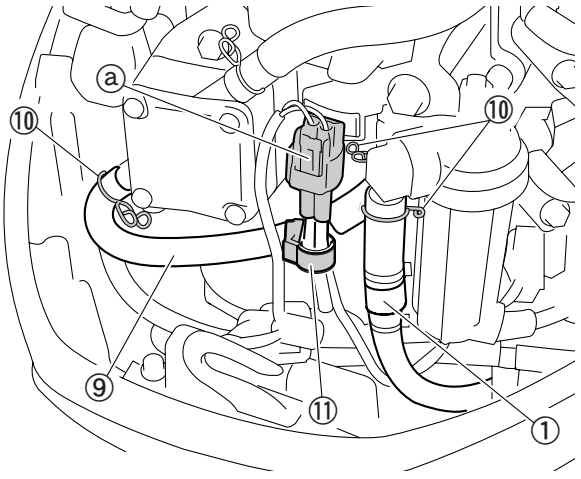


4. Install the fuel filter assembly ⑧.

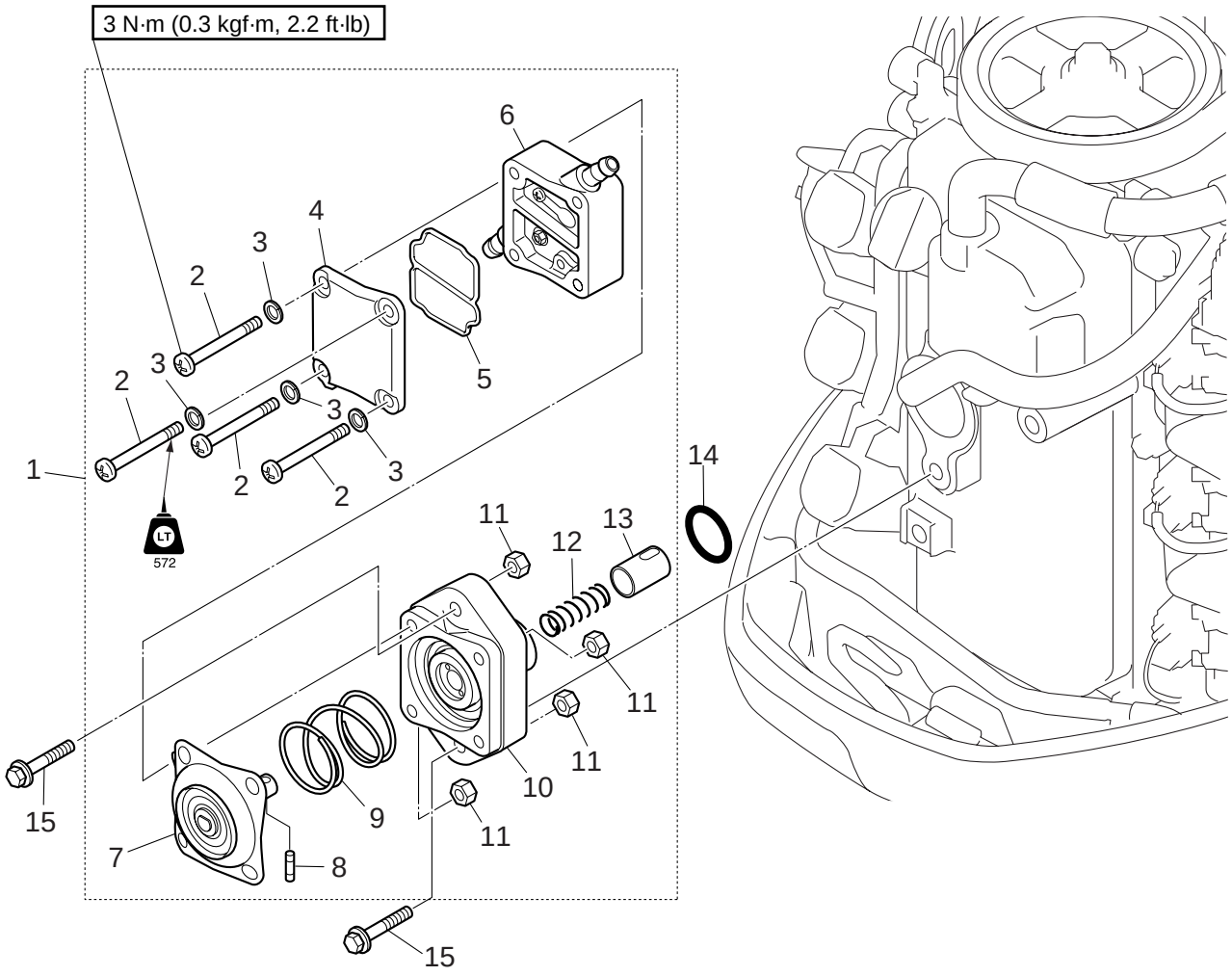


5. Install the fuel hoses ① and ⑨ with the clips ⑩.

6. Install the clamp ⑪, and then connect the water detection switch coupler ⓐ.



Fuel pump assembly

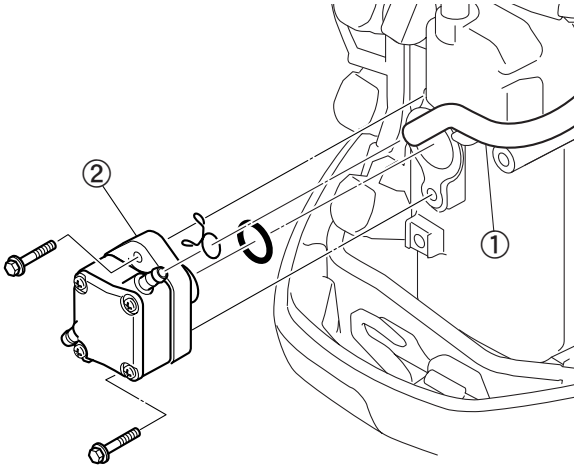


No.	Part name	Q'ty	Remarks
1	Fuel pump assembly	1	
2	Screw	4	M5 × 43 mm
3	Washer	4	
4	Cover	1	
5	Diaphragm	1	**Not reusable**
6	Fuel pump body 2	1	
7	Diaphragm	1	
8	Pin	1	
9	Spring	1	
10	Fuel pump body 1	1	
11	Nut	4	
12	Spring	1	
13	Plunger	1	
14	O-ring	1	**Not reusable**
15	Bolt	2	M6 × 30 mm

Removing the fuel pump assembly

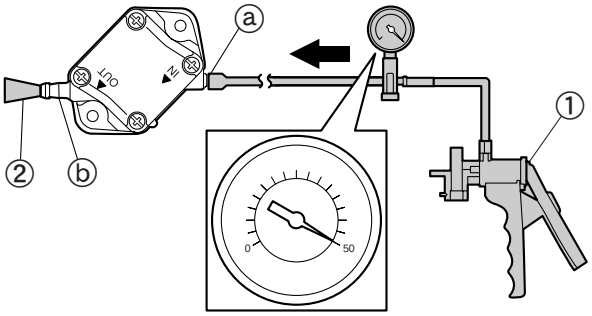
Use a rag to catch any spilled gasoline when removing the fuel components.

1. Disconnect the fuel hose ①.
2. Remove the fuel pump assembly ②.



Checking the fuel pump assembly

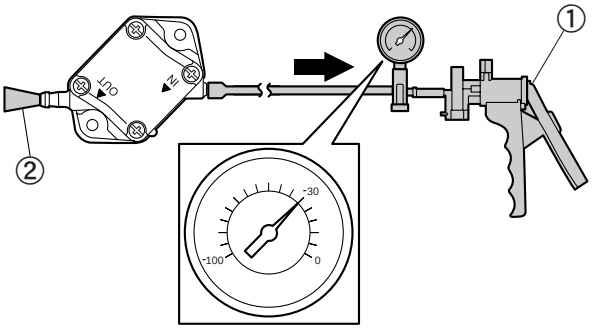
1. Connect the special service tool ① to the fuel pump inlet ⓐ.
2. Cover the fuel pump outlet ⓑ with a rubber plug ②, and then apply the specified positive pressure. Check that there is no air leakage.



Vacuum/pressure pump gauge set ①:
90890-06756

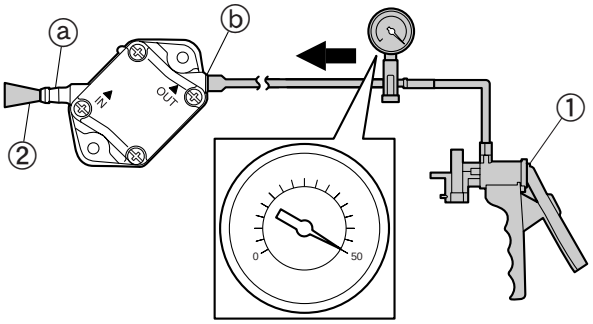
Specified positive pressure:
50.0 kPa (0.50 kgf/cm², 7.3 psi)

3. Apply the specified negative pressure and check that there is no air leakage.



Specified negative pressure:
30.0 kPa (0.30 kgf/cm², 4.4 psi)

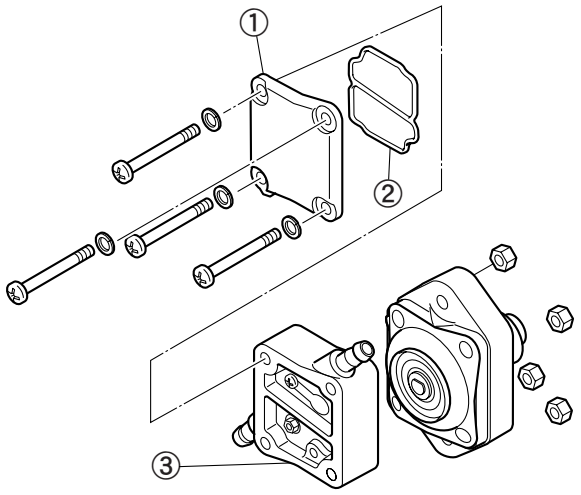
4. Connect the special service tool ① to the fuel pump outlet ⓑ.
5. Cover the fuel pump inlet ⓐ with a rubber plug ②.
6. Apply the specified positive pressure and check that there is no air leakage.



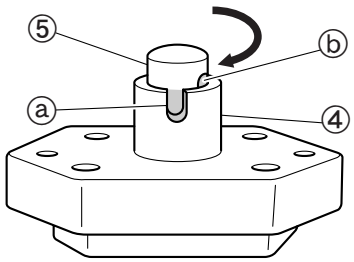
Specified positive pressure:
50.0 kPa (0.50 kgf/cm², 7.3 psi)

Disassembling the fuel pump assembly

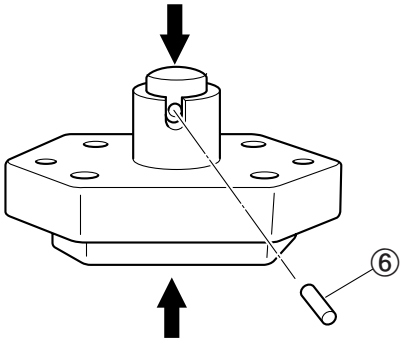
1. Remove the cover ①, the diaphragm ②, and the fuel pump body 2 ③.



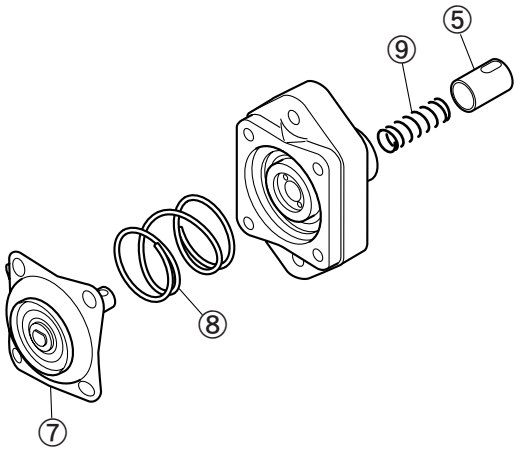
2. Align the groove ⓐ of the fuel pump body 1 ④ with the hole ⓑ of the plunger ⑤ by turning them.



3. Remove the pin ⑥ by pressing the plunger and the diaphragm.

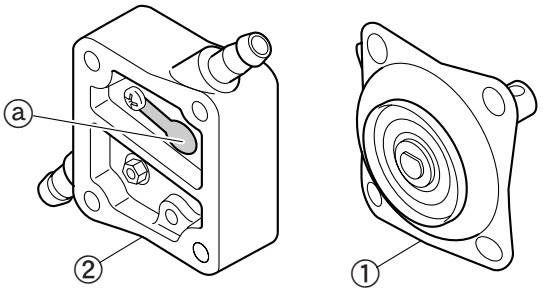


4. Remove the diaphragm ⑦, the spring ⑧, the plunger ⑤, and the spring ⑨.



Checking the diaphragm and valve

1. Check the diaphragm ①. Replace if torn.
2. Check the valves ⓐ. Replace the fuel pump body 2 ② if deformed or worn.

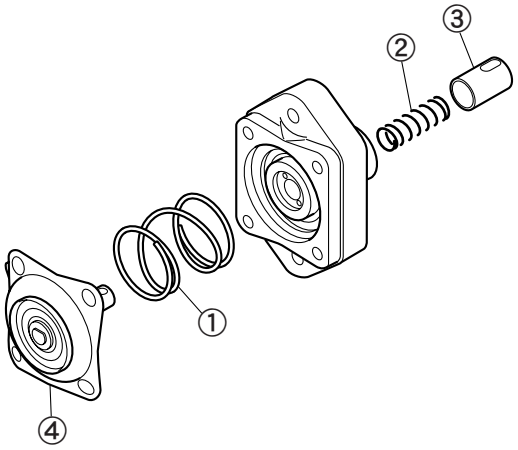


6

Assembling the fuel pump assembly

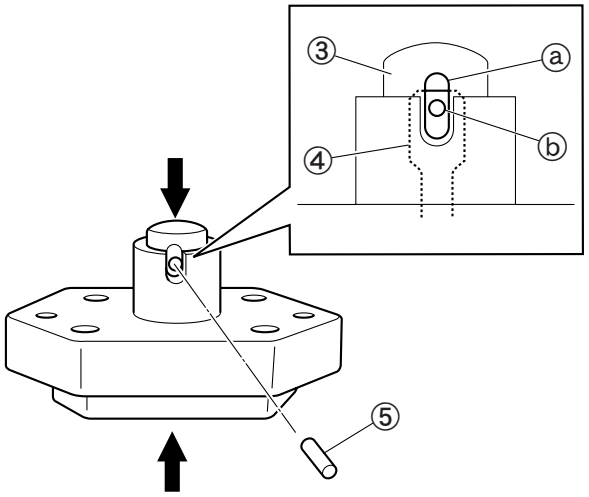
Before assembling the fuel pump assembly, clean the parts and soak the valves and the diaphragm in gasoline to obtain prompt operation of the fuel pump assembly.

1. Install the springs ① and ②, the plunger ③, and the diaphragm ④.

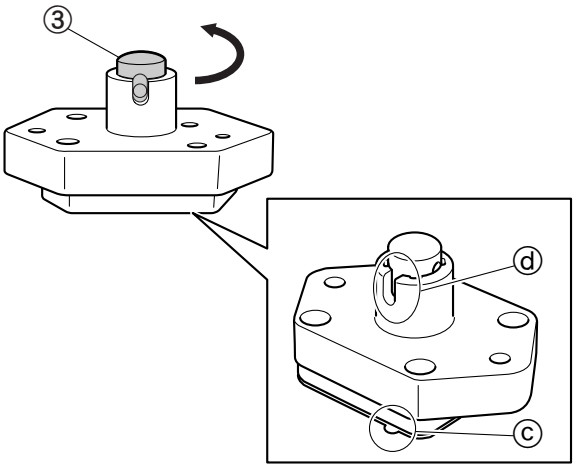


2. Align the hole ⓐ in the plunger ③ with the hole ⓑ in the diaphragm ④ by pushing the plunger and the diaphragm.

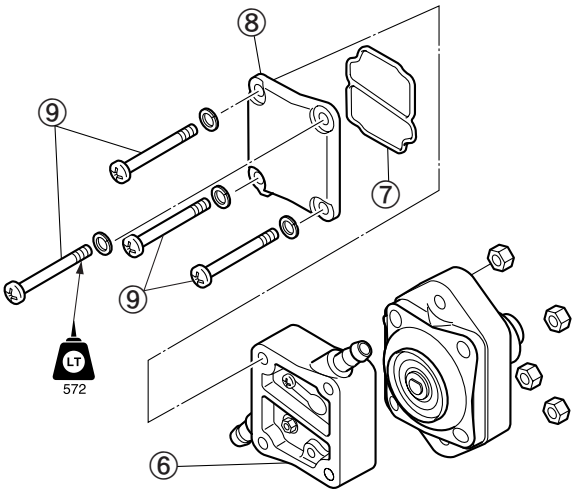
3. Install the pin ⑤.



4. Turn the plunger ③ so that both the diaphragm tab ⓒ and the groove ⓓ face toward the same direction.



5. Install the fuel pump body 2 ⑥, a new diaphragm ⑦, and the cover ⑧, and then tighten the fuel pump screws ⑨ to the specified torque.

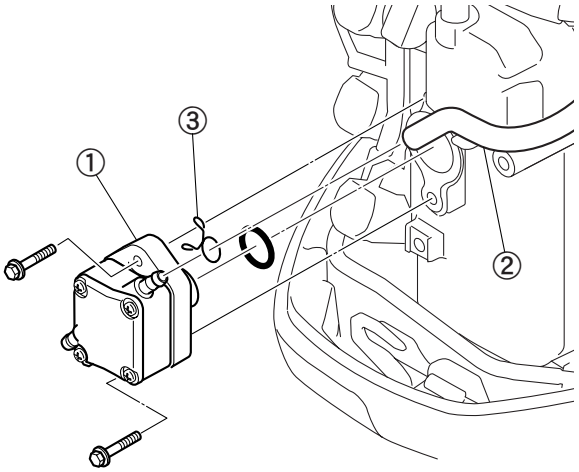


Fuel pump screw ⑨:
3 N·m (0.3 kgf·m, 2.2 ft·lb)

Installing the fuel pump assembly

1. Install the fuel pump assembly ①.

2. Connect the fuel hose ② with the clip ③.

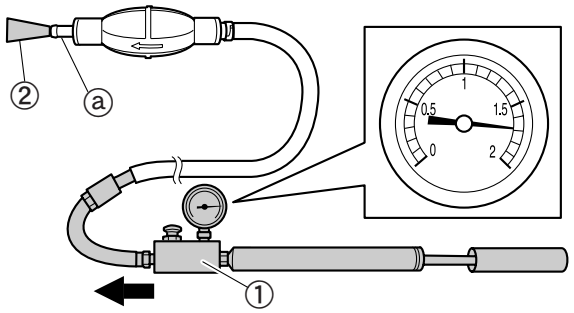


Checking the primer pump

1. Connect the special service tool ① to the primer pump inlet hose.

2. Cover the fuel outlet ⓐ with a rubber plug ②.

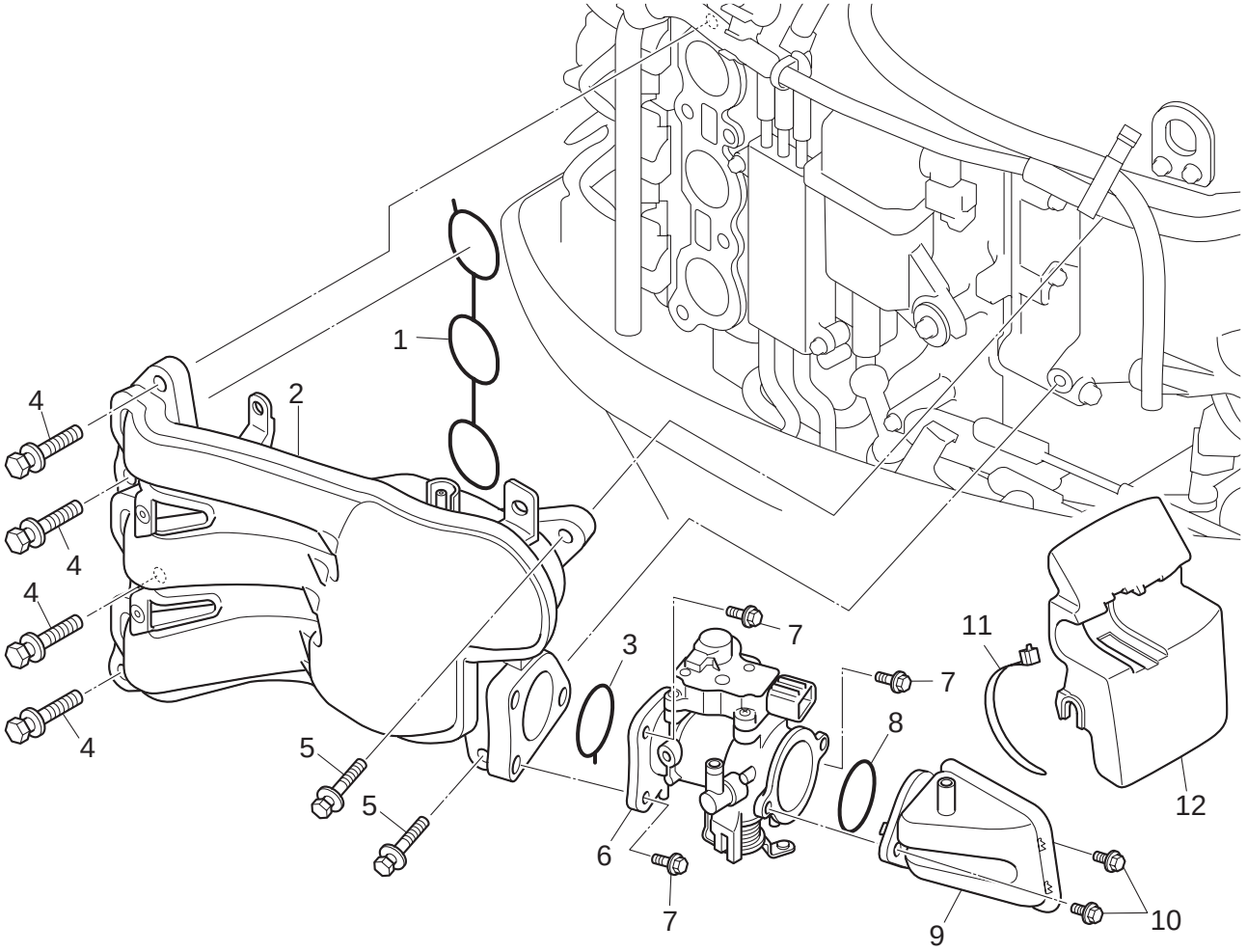
3. Apply the specified positive pressure to check that the pressure is maintained for at least 30 seconds. Replace the primer pump if it does not maintain the pressure.



Leakage tester ①: 90890-06840

Specified positive pressure: 170.0 kPa (1.70 kgf/cm^2, 24.7 psi)

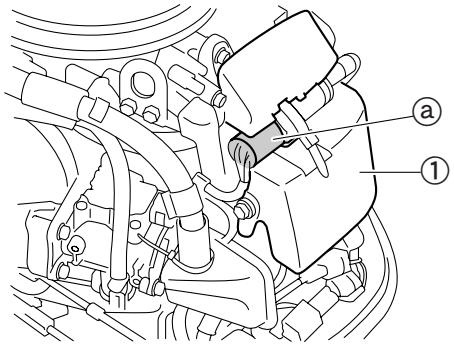
Throttle body



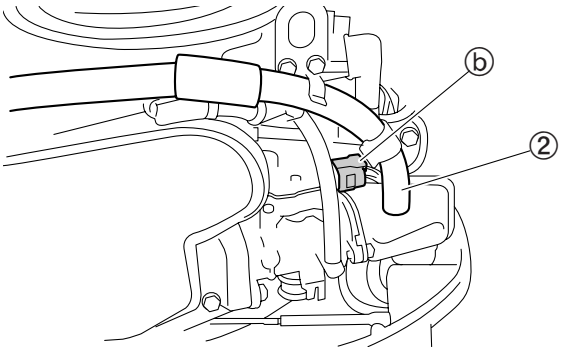
No.	Part name	Q'ty	Remarks
1	Gasket	1	**Not reusable**
2	Intake manifold	1	
3	Gasket	1	**Not reusable**
4	Bolt	4	M8 × 40 mm
5	Bolt	2	M6 × 35 mm
6	Throttle body	1	
7	Bolt	3	M6 × 16 mm
8	O-ring	1	**Not reusable**
9	Intake silencer	1	
10	Bolt	2	M6 × 12 mm
11	Plastic tie	1	
12	Cover	1	

Removing the throttle body

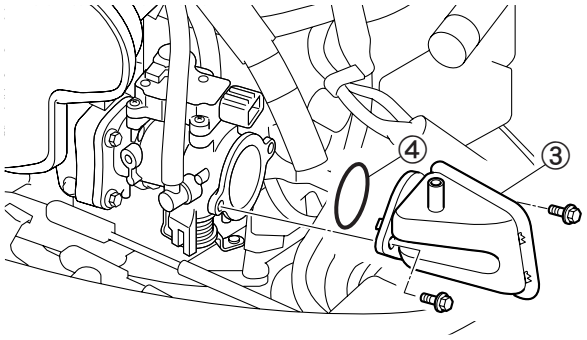
1. Disconnect the 10-pin coupler ⓐ, and then remove the cover ①.



2. Disconnect the throttle body coupler ⓑ and the blowby hose ②.

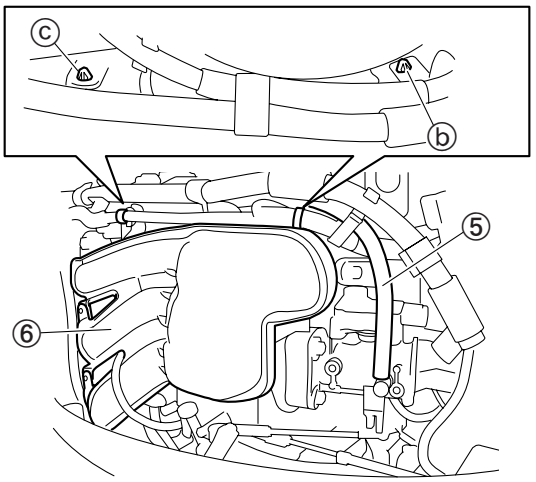


3. Remove the intake silencer ③ and the O-ring ④.

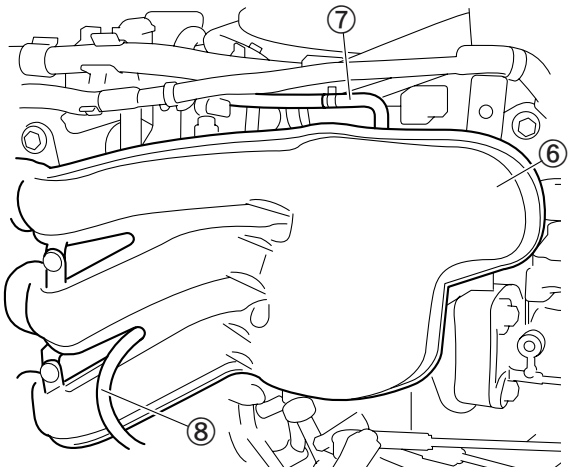


4. Disconnect the vapor gas hose ⑤.

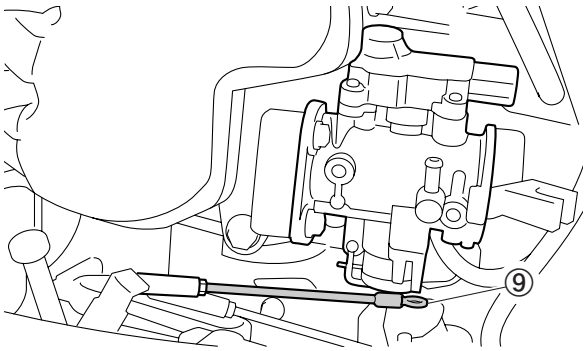
5. Remove the wiring harness clamps ⓑ and ⓒ from the intake manifold ⑥.



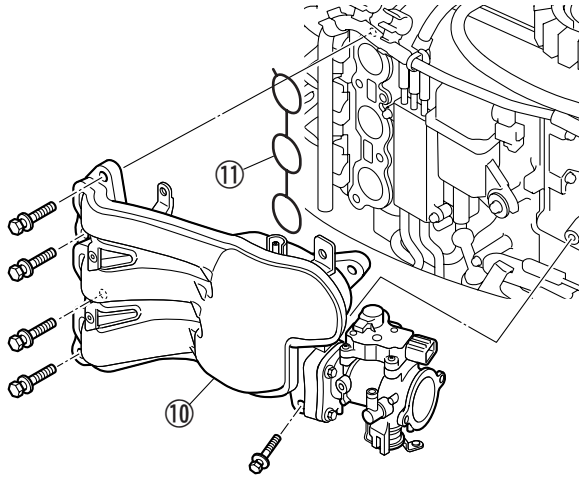
6. Disconnect the pressure regulator hose ⑦, and then remove the drain hose ⑧ from the intake manifold ⑥.



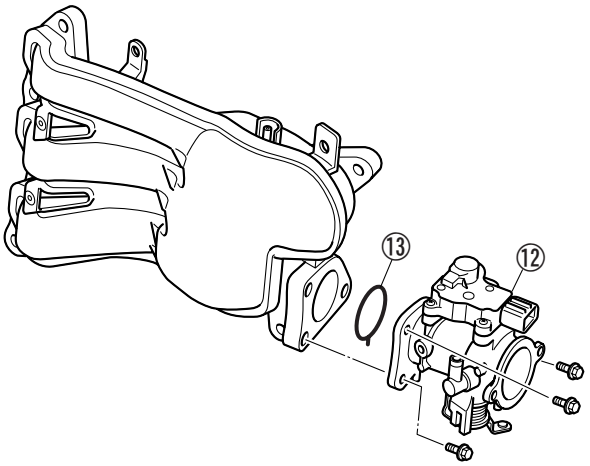
7. Remove the throttle link rod ⑨ from the throttle body side.



8. Remove the intake manifold assembly ⑩ and the gasket ⑪.



9. Remove the throttle body ⑫ and the gasket ⑬.



Checking the intake manifold

1. Check the intake manifold. Replace if cracked or deformed.

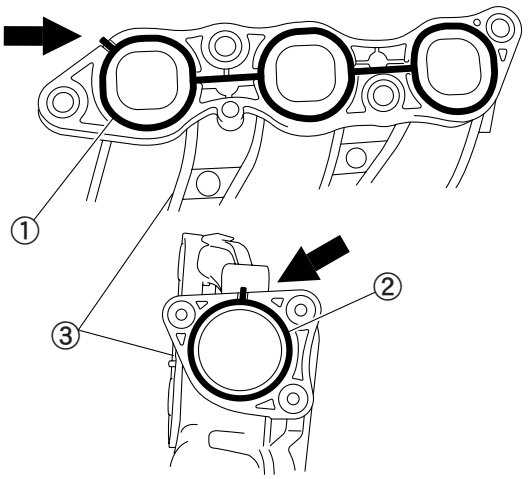
Checking the throttle body

1. Check manually that the throttle valve operates properly.

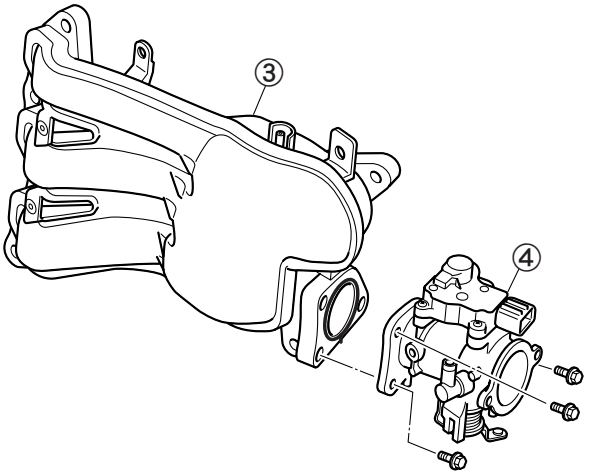
2. Check the throttle body electrical performance. See “Checking the throttle body” (5-17).

Installing the throttle body

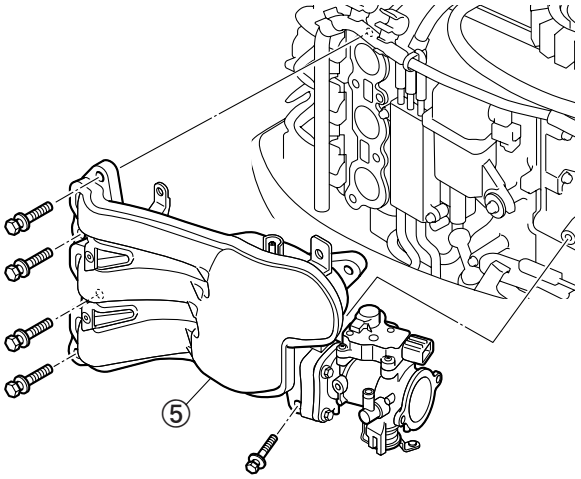
1. Install new gaskets ① and ② onto the intake manifold ③. Make sure that each tab on the gaskets is properly and firmly fitted into the each groove on the intake manifold.



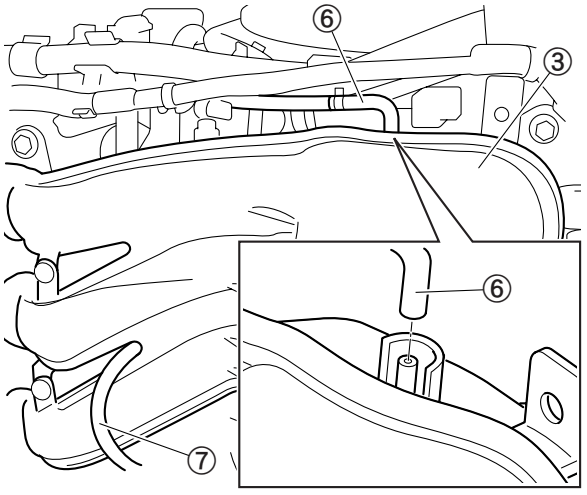
2. Install the throttle body ④ to the intake manifold ③.



3. Install the intake manifold assembly ⑤.

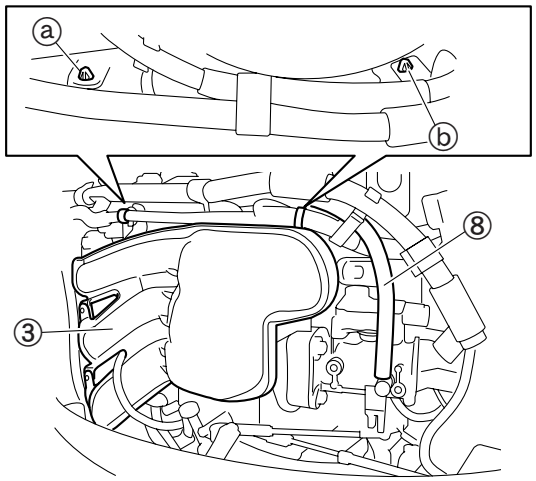


4. Connect the pressure regulator hose ⑥, and then install the drain hose ⑦ to the intake manifold ③.

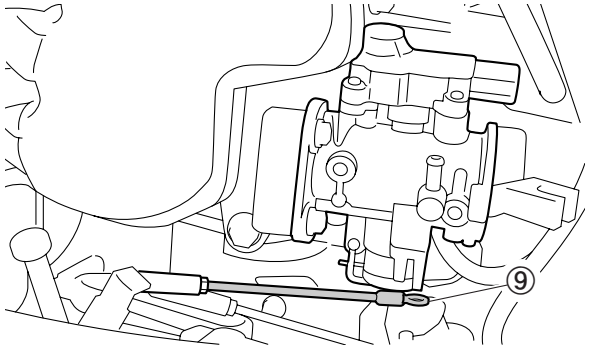


5. Install the wiring harness clamps ⓐ and ⓑ to the intake manifold ③.

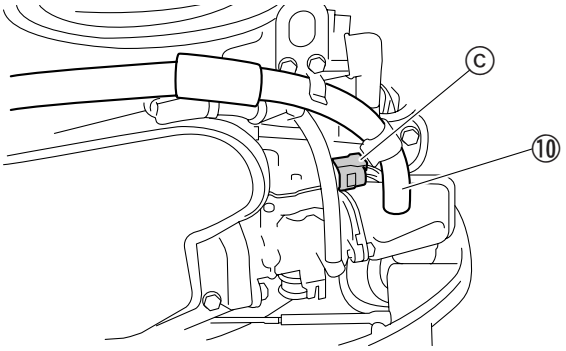
6. Connect the vapor gas hose ⑧.



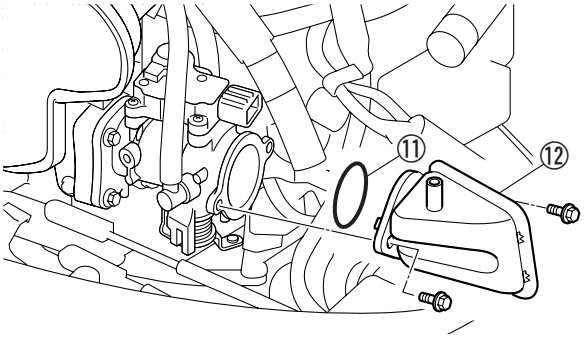
7. Connect the throttle link rod ⑨ of the throttle body side.



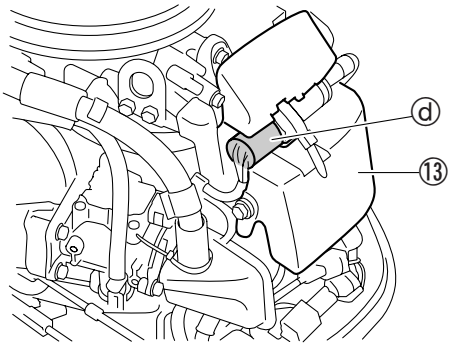
8. Connect the throttle body coupler ⓒ and the blowby hose ⑩.



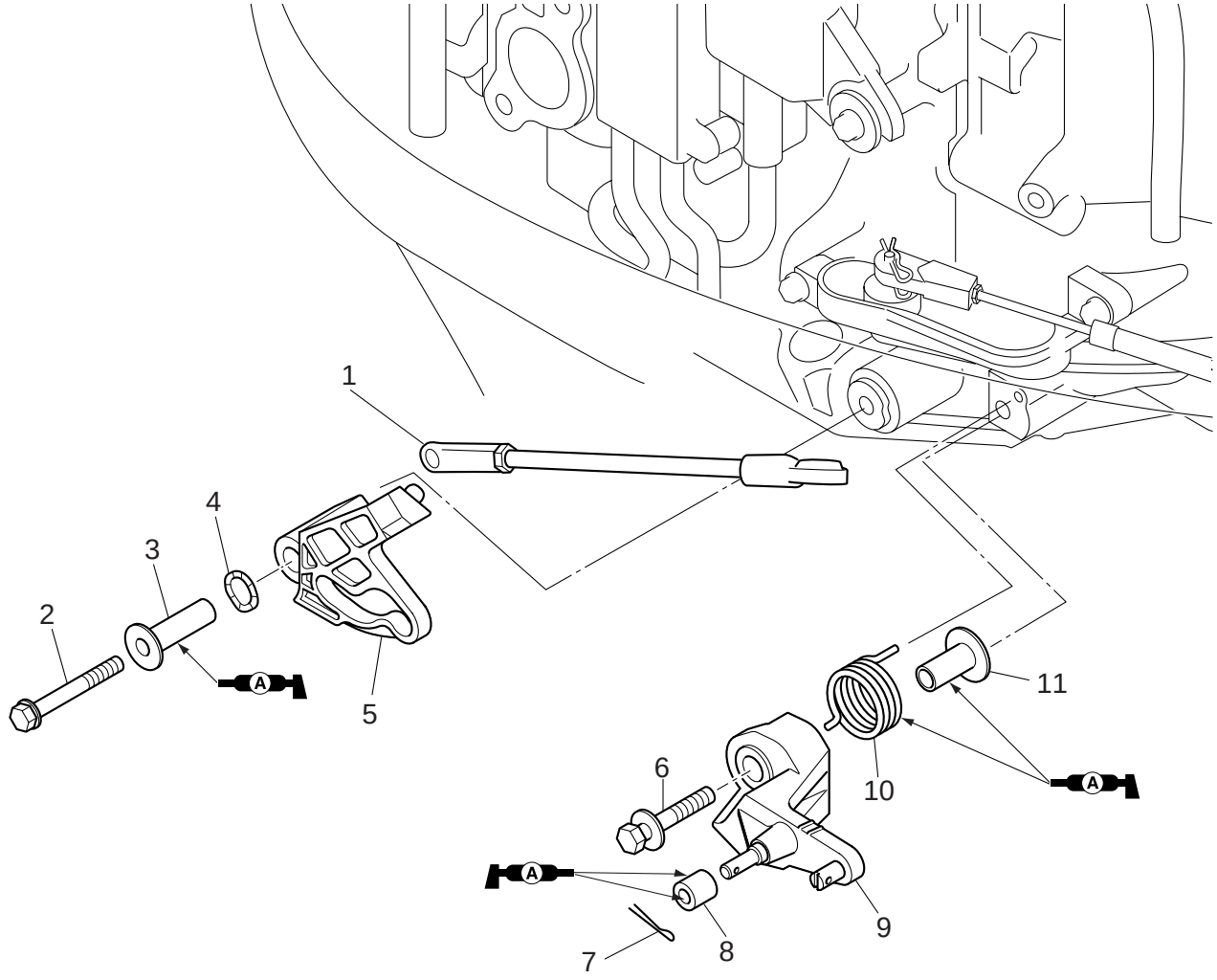
9. Install a new O-ring ⑪ and the silencer ⑫.



10. Install the cover ⑬, and then connect the 10-pin coupler ⓓ.



Throttle link rod

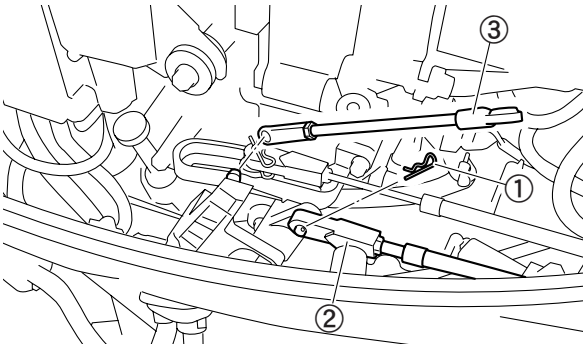


No.	Part name	Q'ty	Remarks
1	Throttle link rod	1	
2	Bolt	1	M6 × 45 mm
3	Collar	1	
4	Wave washer	1	
5	Throttle cam	1	
6	Bolt	1	M6 × 35 mm
7	Cotter pin	1	**Not reusable**
8	Throttle cam roller	1	
9	Throttle control lever	1	
10	Spring	1	
11	Collar	1	

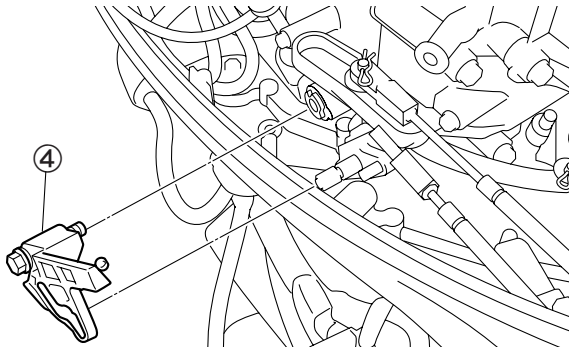
Removing the throttle link

1. Remove the clip ① and the throttle cable ②.

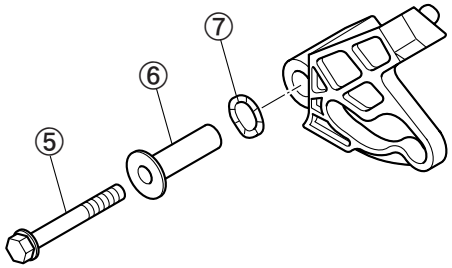
2. Remove the link rod ③.



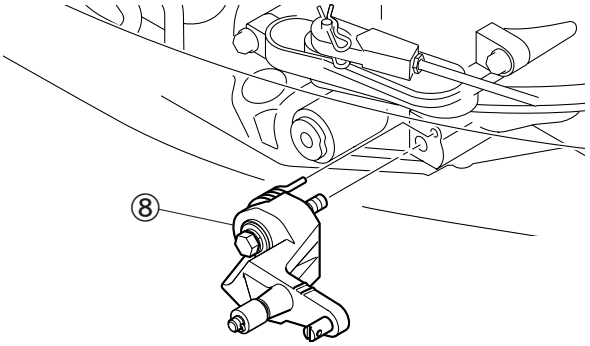
3. Remove the throttle cam assembly ④.



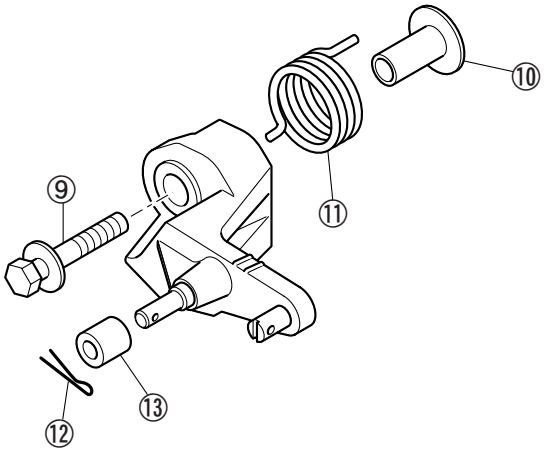
4. Remove the bolt ⑤, the collar ⑥, and the wave washer ⑦.



5. Remove the throttle lever assembly ⑧.

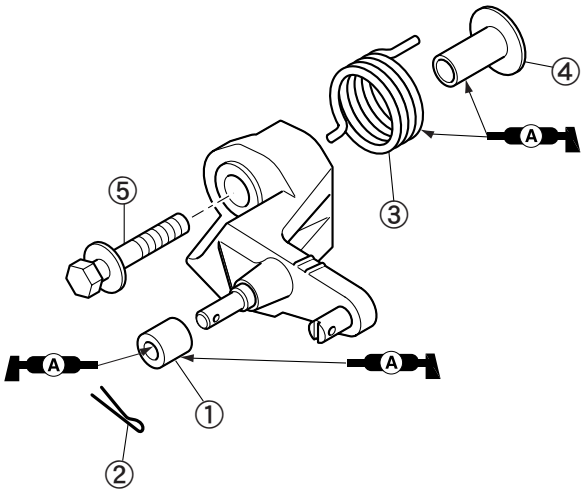


6. Remove the bolt ⑨, the collar ⑩, the spring ⑪, the cotter pin ⑫, and the roller ⑬.

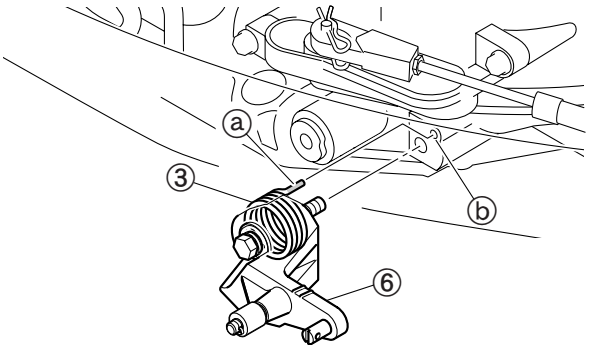


Installing the throttle link

1. Install the roller ①, a new cotter pin ②, the spring ③, the collar ④, and the bolt ⑤.



2. Install the throttle lever assembly ⑥ to the crankcase. Make sure to fit the end ⓐ of the spring ③ into the hole ⓑ of the crankcase.



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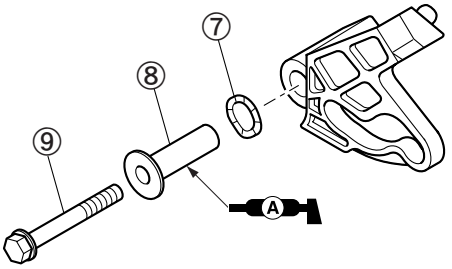
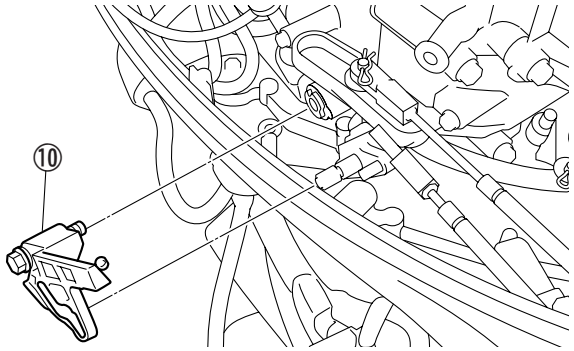
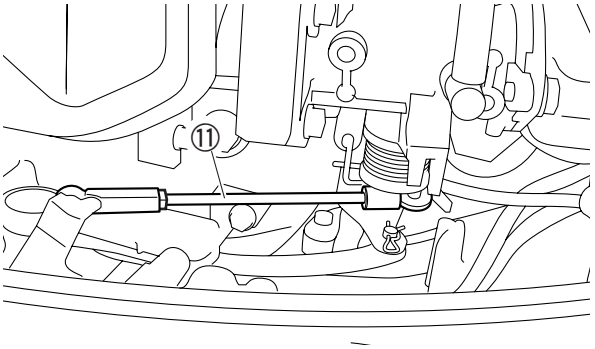
3. Install the wave washer ⑦, the collar ⑧, and the bolt ⑨.



4. Install the throttle cam assembly ⑩.



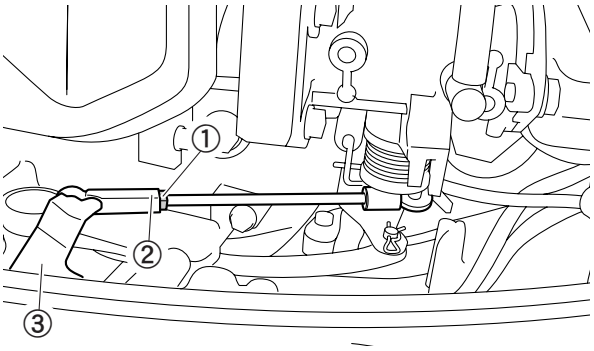
5. Adjust the throttle link rod ⑪, and then install it.



6. Install the throttle cable and the clip. See "Installing the shift cable and throttle cable (remote control model)" (3-14).

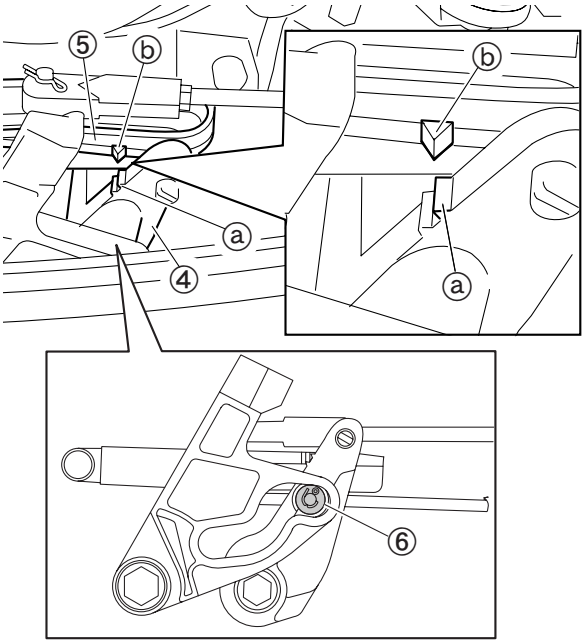
Adjusting the throttle link rod

1. Loosen the locknut ①, and then remove the throttle link rod ② from the throttle cam ③.



2. Make sure that the protrusion ⓐ on the throttle lever ④ and the protrusion ⓑ on the shift bracket ⑤ are aligned.

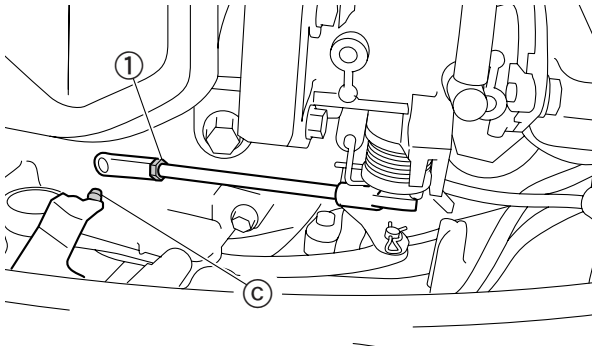
3. Set the throttle cam until it slightly contacts the roller ⑥.



4. Adjust the throttle link rod length so that it fits onto the protrusion ⓒ of the throttle cam, and then install the throttle link rod to the throttle cam.

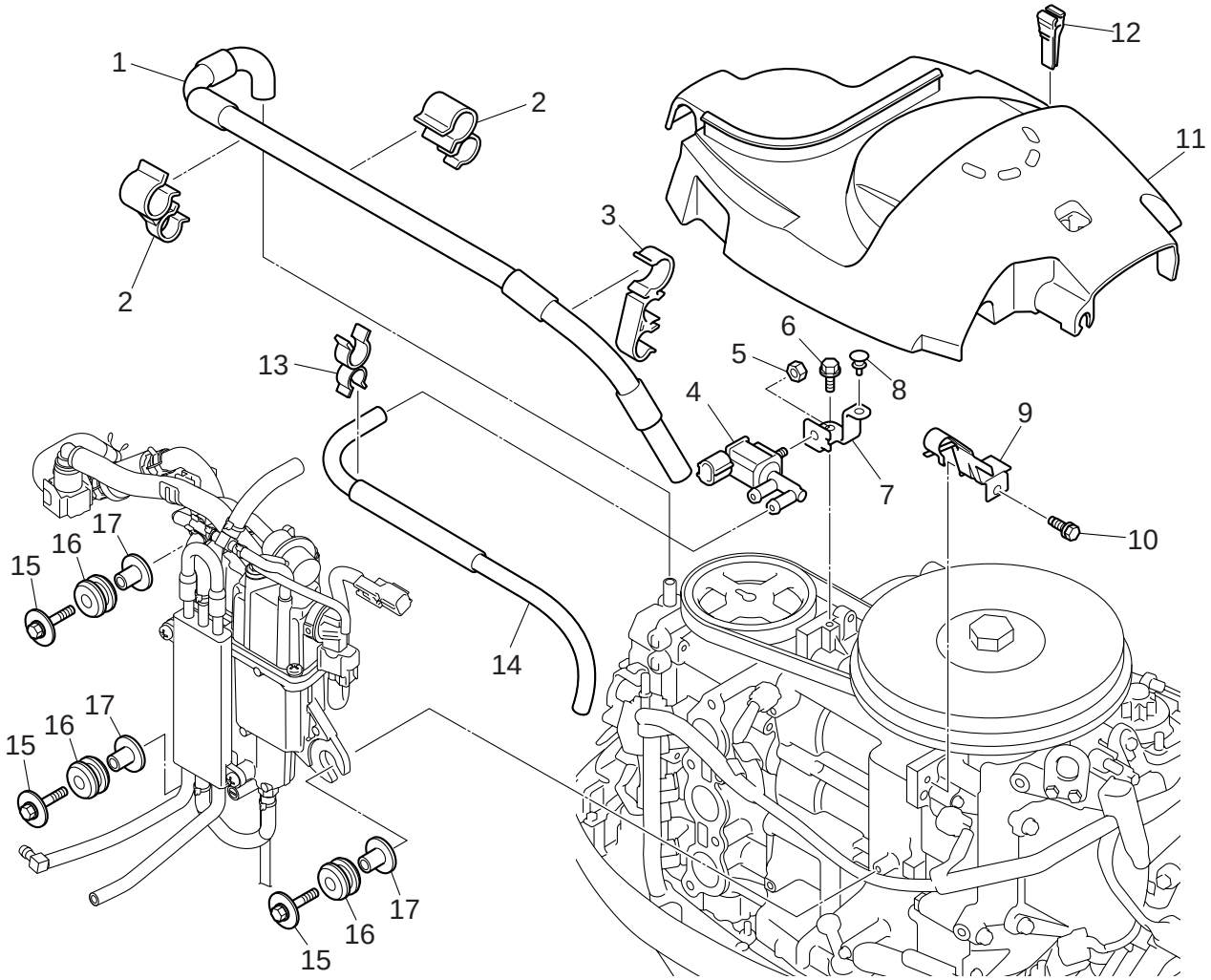
TIP:
Adjust the throttle link rod length with the protrusions ⓐ and ⓑ aligned.

5. Tighten the link rod locknut ① to the specified torque.



Link rod locknut ①: 5 N·m (0.5 kgf·m, 3.7 ft·lb)

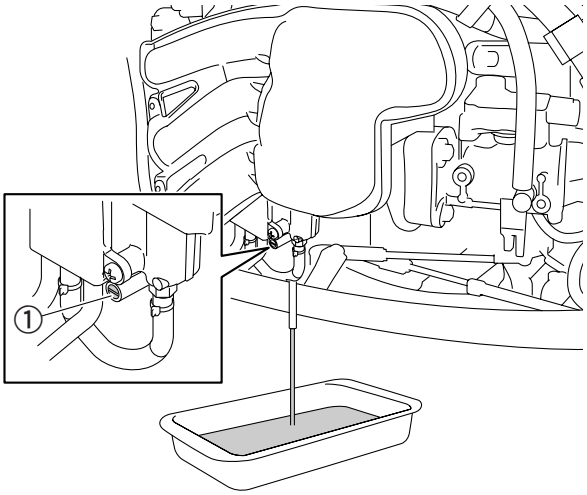
Vapor separator

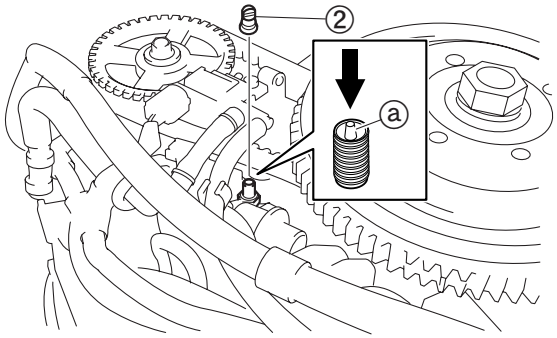


No.	Part name	Q'ty	Remarks
1	Hose	1	
2	Holder	2	
3	Holder	1	
4	Vapor shut-off valve	1	
5	Nut	1	
6	Bolt	1	M6 × 16 mm
7	Bracket	1	
8	Grommet	1	
9	Bracket	1	
10	Bolt	1	M6 × 20 mm
11	Cover	1	
12	Fuse puller	1	
13	Holder	1	
14	Hose	1	
15	Bolt	3	M6 × 30 mm
16	Grommet	3	
17	Collar	3	

Draining the fuel

1. Drain the remaining gasoline in the vapor separator into a drain pan. Loosen the drain screw ①, and then remove the cap ②. Push in the air valve ⓐ with a screwdriver.





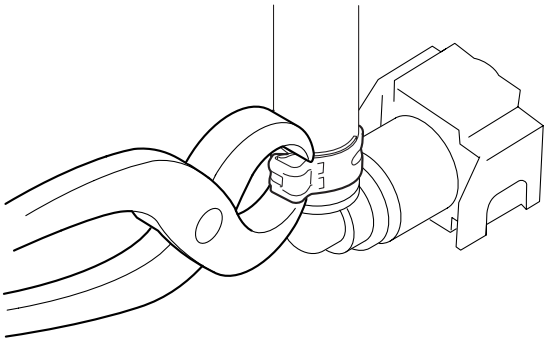
2. Tighten the drain screw ① to the specified torque, and then install the cap ②.

Vapor separator drain screw ①:
1.5 N·m (0.15 kgf·m, 1.11 ft·lb)

Removing the fuel hose clamp

1. Reduce the fuel pressure. See “Reducing the fuel pressure” (6-4).

2. Remove the fuel hose clamp by cutting the crimped section of the clamp. ***NOTICE:*** **If the fuel hose clamp is removed without cutting the crimp first, the fuel hose could be damaged.**

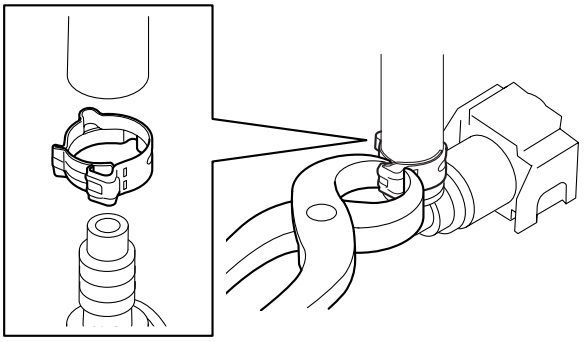


Installing the fuel hose clamp

⚠ WARNING

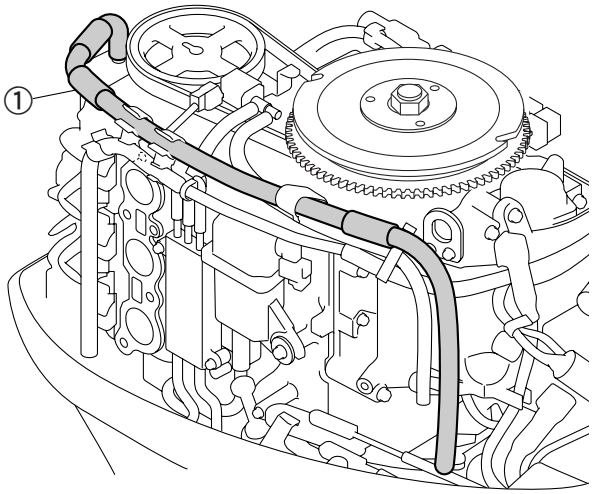
Do not reuse the fuel hose clamp. Always replace it with a new one.

1. Crimp the fuel hose clamp properly to securely fasten the fuel hose and the quick connector.



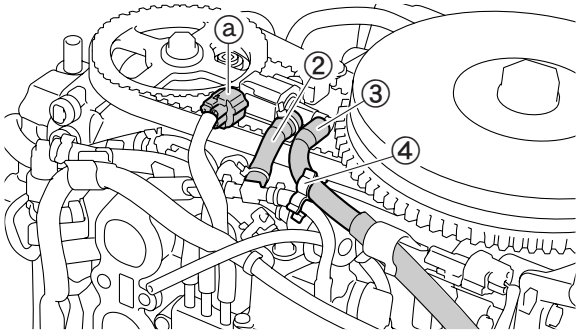
Removing the vapor separator

1. Remove the blowby hose ①.

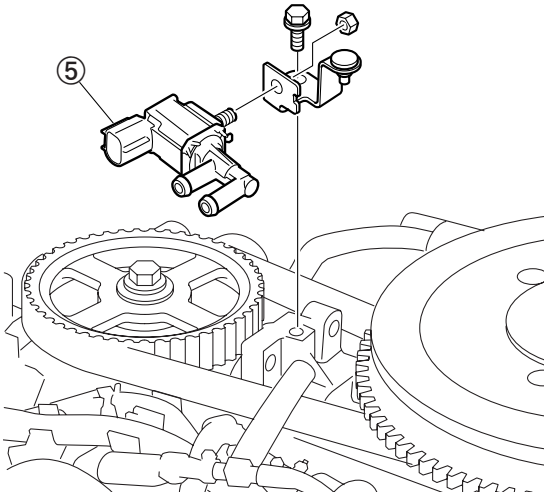


6

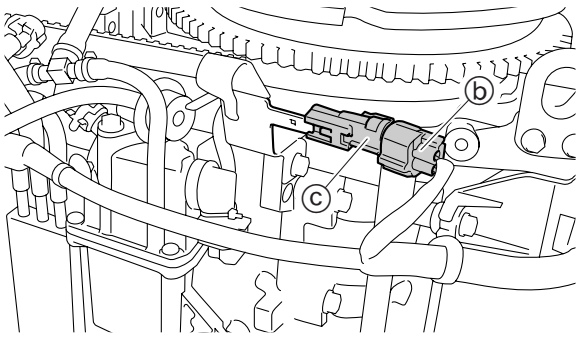
2. Disconnect the vapor shut-off valve coupler ⓐ, and then remove the vapor gas hoses ②, ③, and the holder ④.



3. Remove the vapor shut-off valve ⑤.

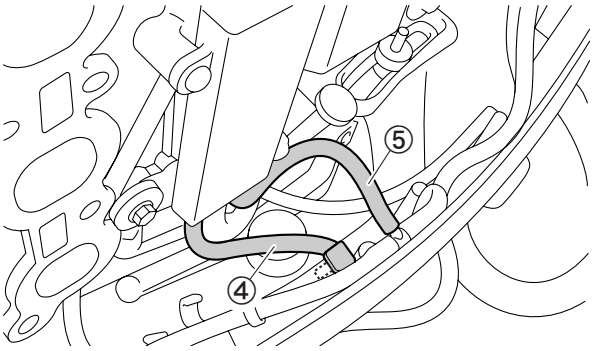


4. Disconnect the high-pressure fuel pump coupler ⓑ, and then remove the high-pressure fuel pump coupler ⓒ.

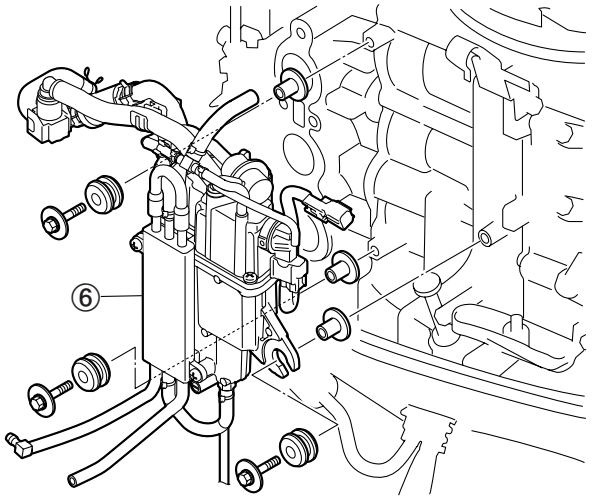


5. Disconnect the quick connector. See “Disconnecting the quick connector” (6-4).

6. Disconnect the cooling water hoses ④ and ⑤.



7. Remove the vapor separator assembly ⑥.



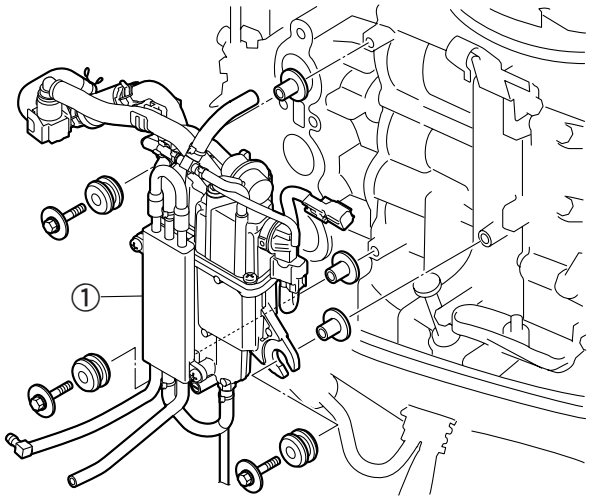
Checking the vapor shut-off valve

1. Check the vapor shut-off valve exterior. Replace if cracked.

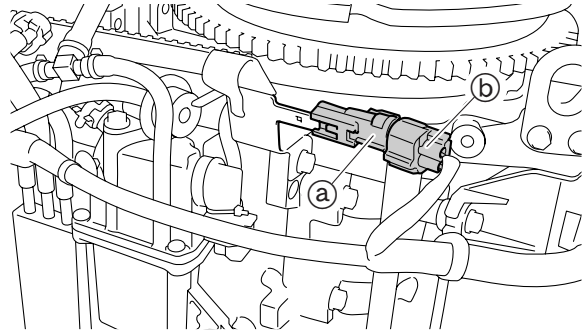
2. Check the vapor shut-off valve electrical performance. See “Checking the vapor shut-off valve” (5-23).

Installing the vapor separator

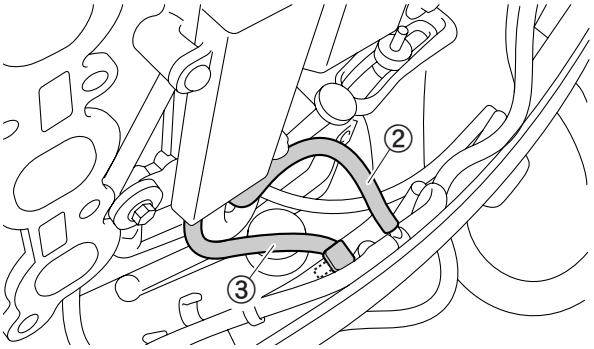
1. Install the vapor separator assembly ①.



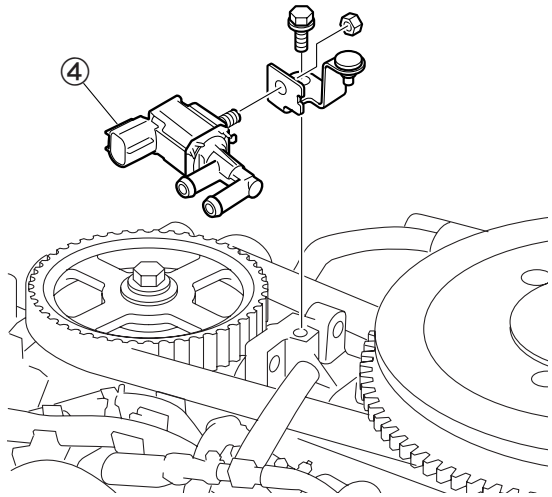
2. Install the high-pressure fuel pump coupler ⓐ, and then connect the fuel pump coupler ⓑ.



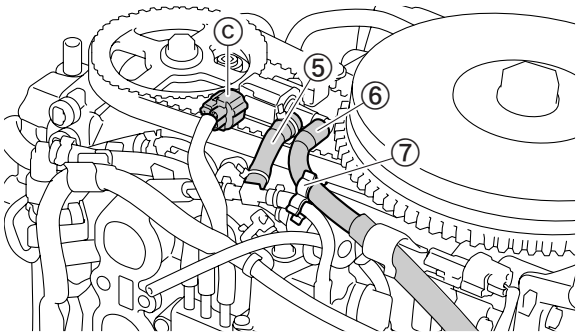
3. Connect the fuel cooling water hoses ② and ③.



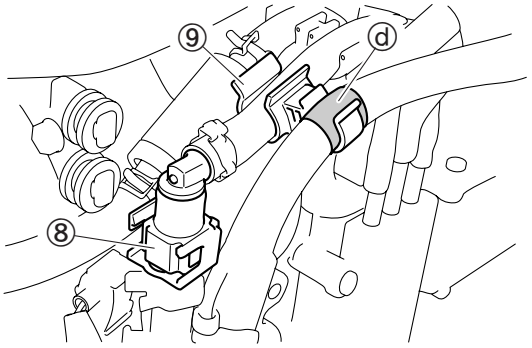
4. Install the vapor shut-off valve ④.



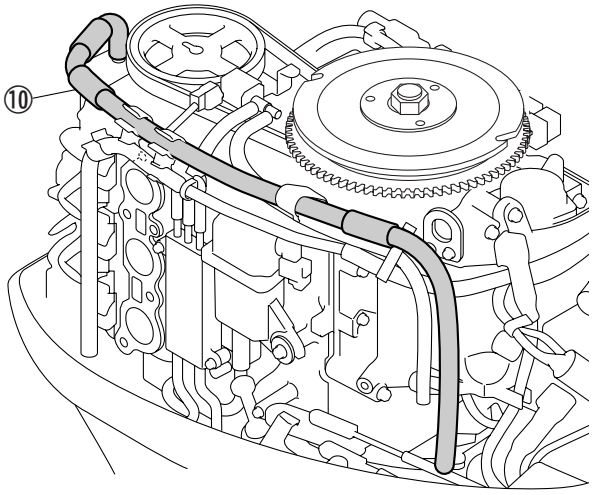
5. Connect the vapor shut-off valve coupler ⓒ, and then install the vapor gas hoses ⑤, ⑥, and the holder ⑦.



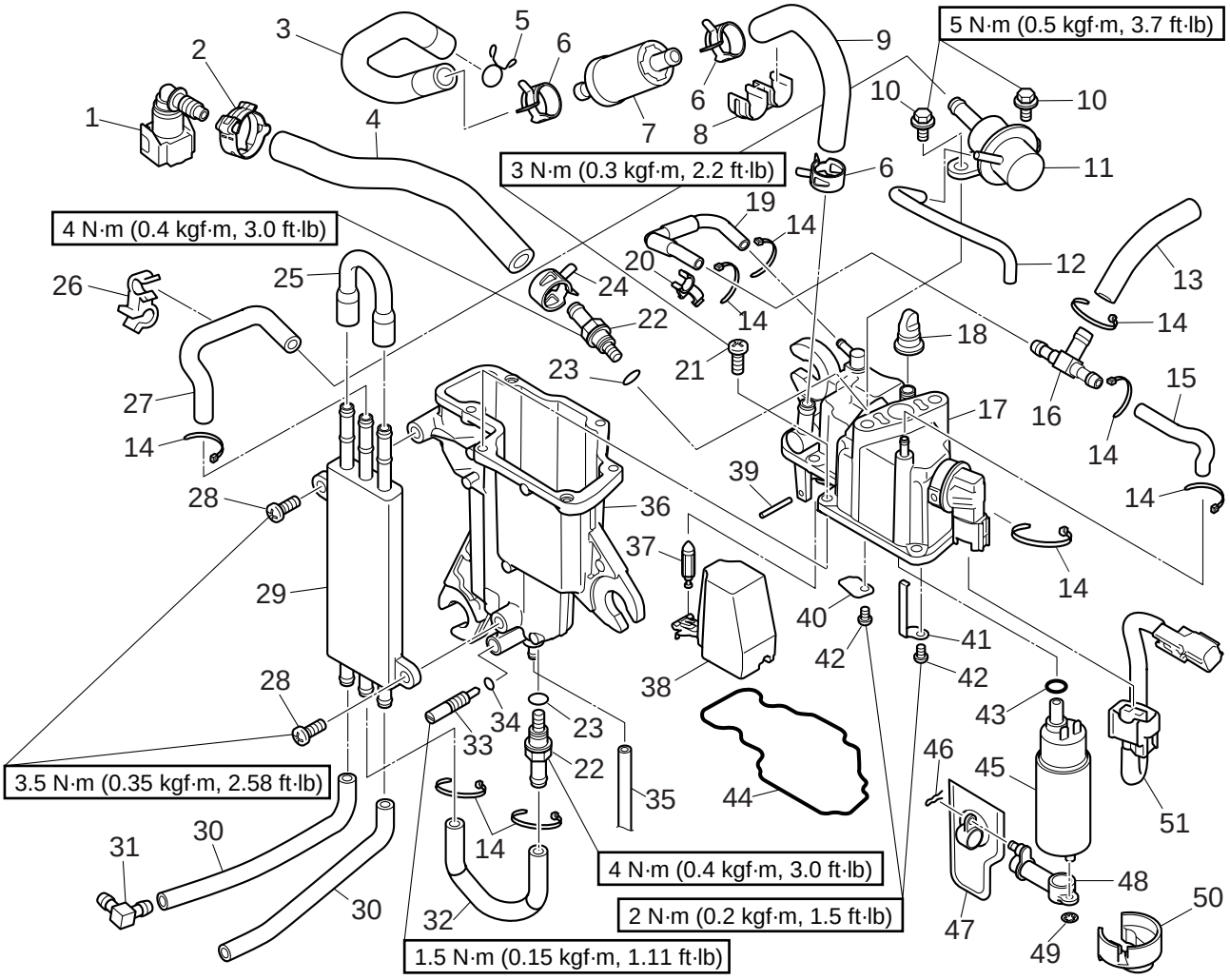
6. Connect the quick connector ⑧, and then install the holder ⑨ aligning it with the white tape ⓓ of the wiring harness.



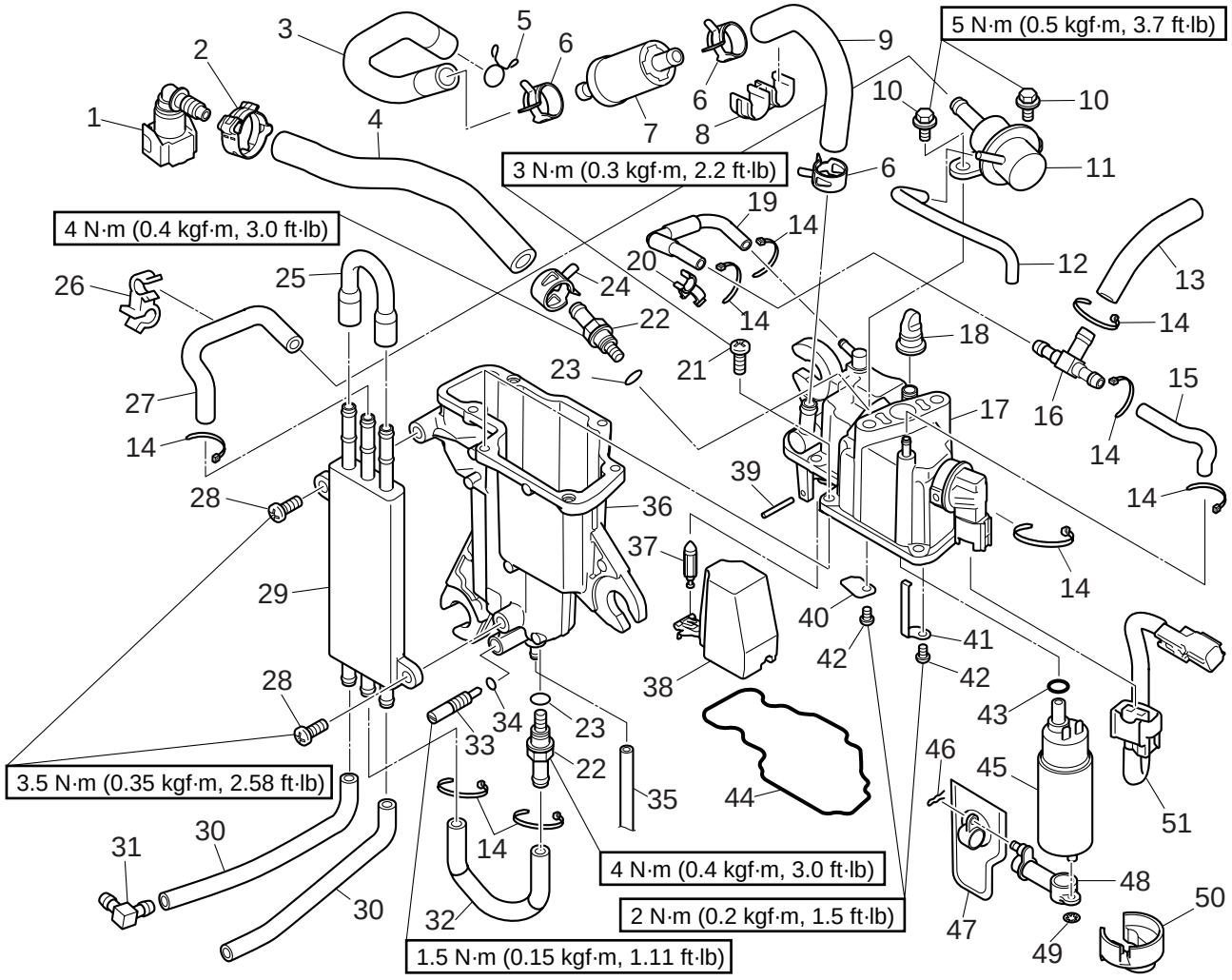
7. Install the blowby hose ⑩.



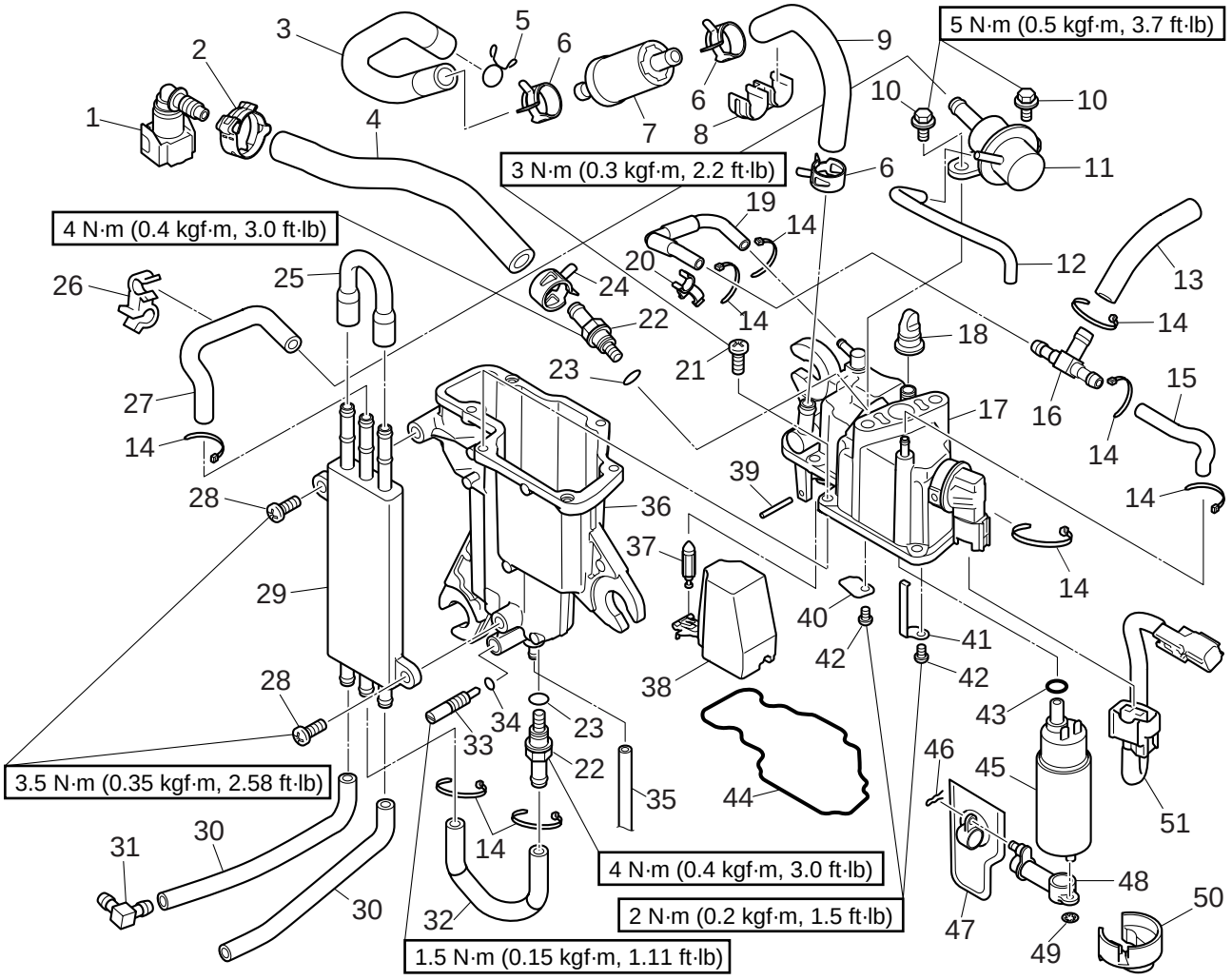
Vapor separator (disassembly)


5 N·m (0.5 kgf·m, 3.7 ft·lb)
3 N·m (0.3 kgf·m, 2.2 ft·lb)
4 N·m (0.4 kgf·m, 3.0 ft·lb)
3.5 N·m (0.35 kgf·m, 2.58 ft·lb)
4 N·m (0.4 kgf·m, 3.0 ft·lb)
2 N·m (0.2 kgf·m, 1.5 ft·lb)
1.5 N·m (0.15 kgf·m, 1.11 ft·lb)

No.	Part name	Q'ty	Remarks
1	Quick connector	1	
2	Clamp	1	
3	Hose	1	
4	Hose	1	
5	Clip	1	
6	Clamp	3	
7	Strainer	1	
8	Holder	1	
9	Hose	1	
10	Bolt	2	M6 × 12 mm
11	Pressure regulator	1	
12	Hose	1	
13	Hose	1	
14	Plastic tie	9	**Not reusable**
15	Hose	1	
16	Joint	1	
17	Cover	1	


5 N·m (0.5 kgf·m, 3.7 ft·lb)
3 N·m (0.3 kgf·m, 2.2 ft·lb)
4 N·m (0.4 kgf·m, 3.0 ft·lb)
3.5 N·m (0.35 kgf·m, 2.58 ft·lb)
4 N·m (0.4 kgf·m, 3.0 ft·lb)
2 N·m (0.2 kgf·m, 1.5 ft·lb)
1.5 N·m (0.15 kgf·m, 1.11 ft·lb)

No.	Part name	Q'ty	Remarks
18	Cap	1	
19	Hose	1	
20	Holder	1	
21	Screw	6	M5 × 14 mm
22	Nipple	2	
23	O-ring	2	**Not reusable**
24	Clamp	1	
25	Hose	1	
26	Holder	1	
27	Hose	1	
28	Screw	2	M6 × 14 mm
29	Fuel cooler	1	
30	Hose	2	
31	Joint	1	
32	Hose	1	
33	Drain screw	1	
34	O-ring	1	**Not reusable**

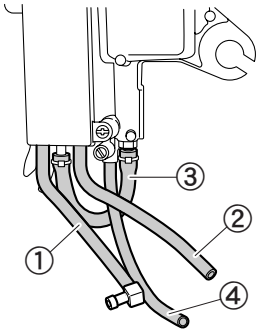

5 N·m (0.5 kgf·m, 3.7 ft·lb)
3 N·m (0.3 kgf·m, 2.2 ft·lb)
4 N·m (0.4 kgf·m, 3.0 ft·lb)
3.5 N·m (0.35 kgf·m, 2.58 ft·lb)
4 N·m (0.4 kgf·m, 3.0 ft·lb)
2 N·m (0.2 kgf·m, 1.5 ft·lb)
1.5 N·m (0.15 kgf·m, 1.11 ft·lb)

No.	Part name	Q'ty	Remarks
35	Drain hose	1	
36	Float chamber	1	
37	Needle valve	1	
38	Float	1	
39	Pin	1	**Not reusable**
40	Plate	1	
41	Plate	1	
42	Screw	2	M4 × 7 mm
43	O-ring	1	**Not reusable**
44	Gasket	1	**Not reusable**
45	High-pressure fuel pump	1	
46	Clip	1	
47	Filter	1	
48	Joint	1	
49	Clip	1	
50	Holder	1	
51	Lead	1	

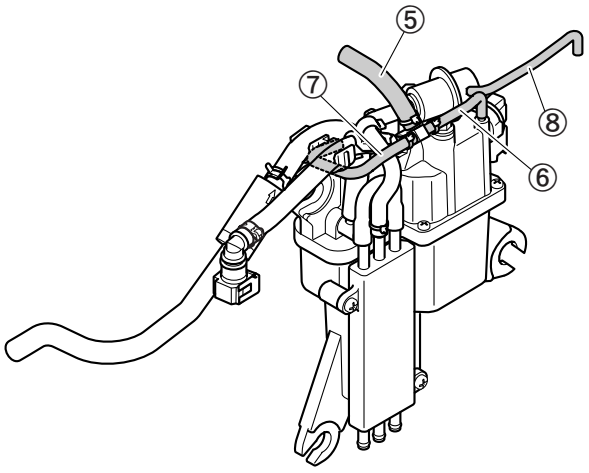
Disassembling the vapor separator

1. Remove the cooling water hoses ① and ②.

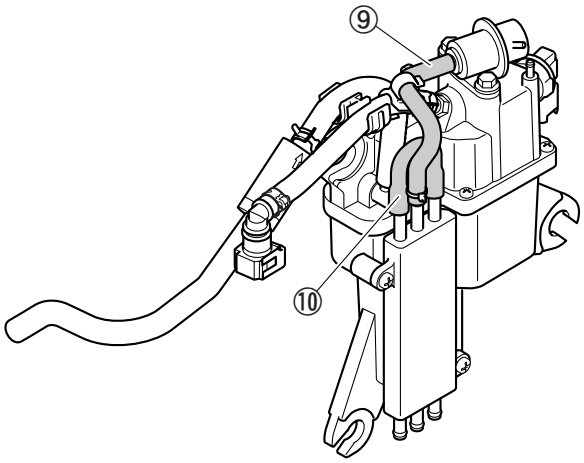
2. Remove the fuel hose ③ and the drain hose ④.



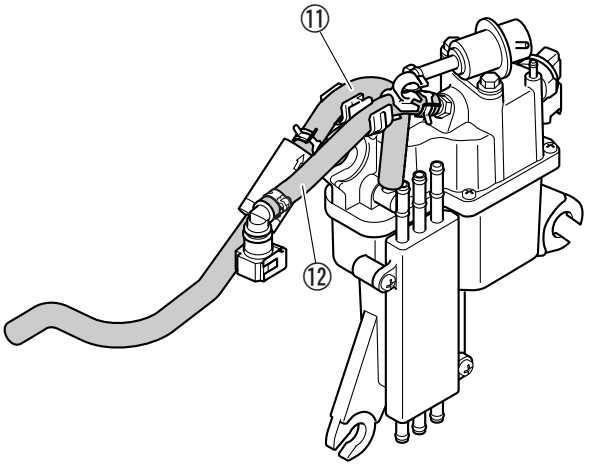
3. Remove the vapor gas hoses ⑤, ⑥, ⑦ and the pressure regulator hose ⑧.



4. Remove the fuel hose ⑨ and the cooling water hose ⑩.

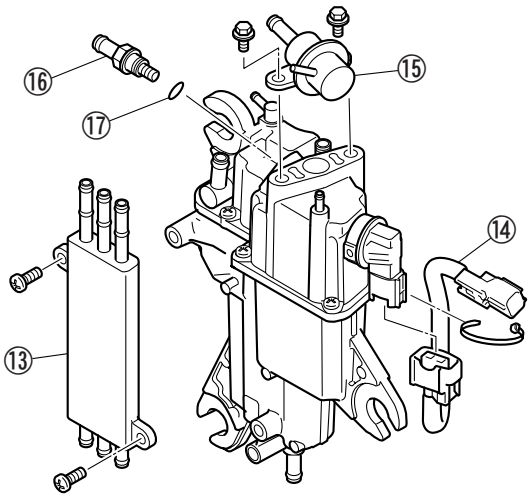


5. Remove the fuel hoses ⑪ and ⑫.

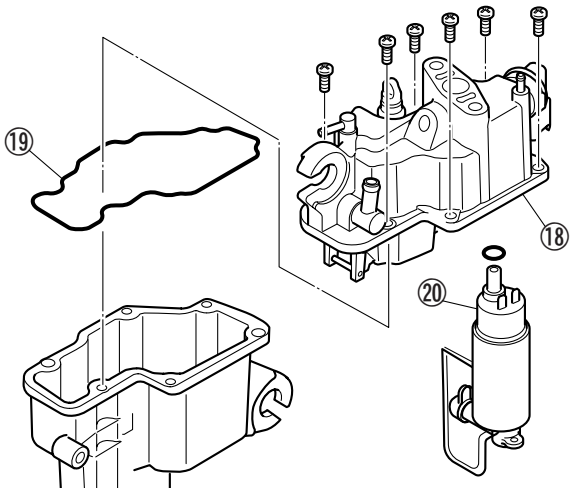


6. Remove the fuel cooler ⑬.

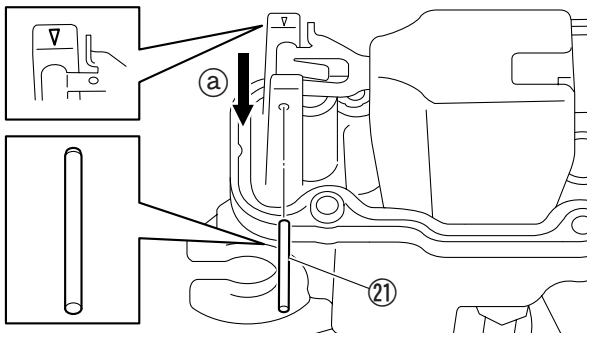
7. Remove the lead ⑭, the pressure regulator ⑮, the nipple ⑯, and the O-ring ⑰.



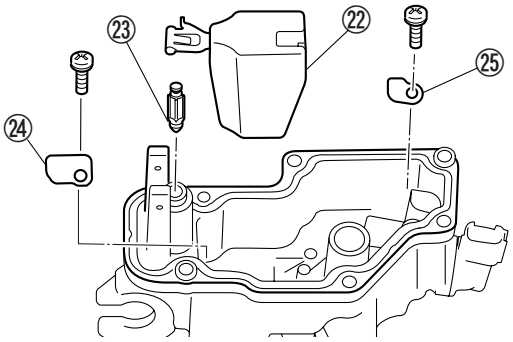
8. Remove the cover assembly ⑱, the gasket ⑲, and the high-pressure fuel pump ⑳.



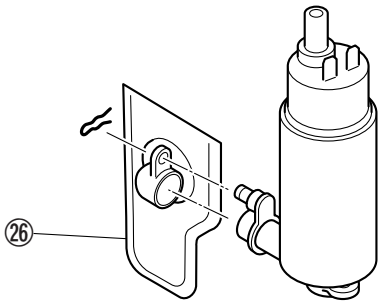
9. Remove the pin ㉑ in the direction of the arrow ⓐ.



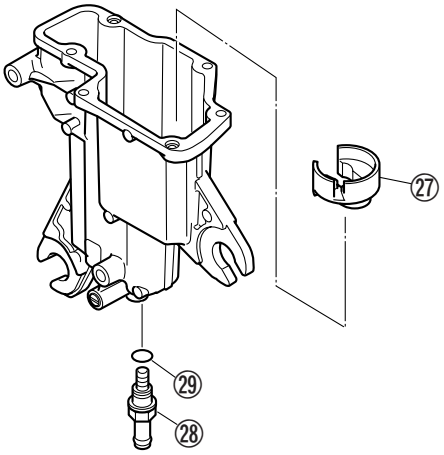
10. Remove the float ㉒, the needle valve ㉓, and the plates ㉔ and ㉕.



11. Remove the filter ㉖.



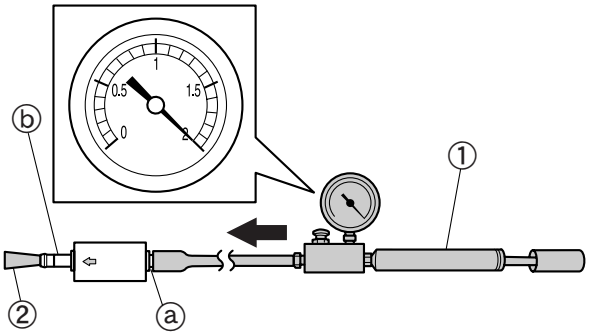
12. Remove the filter holder ㉗, the nipple ㉘, and the O-ring ㉙.



Checking the fuel strainer

1. Connect the special service tool ① to the fuel inlet ⓐ.

2. Cover the fuel outlet ⓑ with a rubber plug ②, and then apply the specified positive pressure. Replace the fuel strainer if the specified pressure cannot be maintained for at least 15 seconds.



Leakage tester ①: 90890-06840

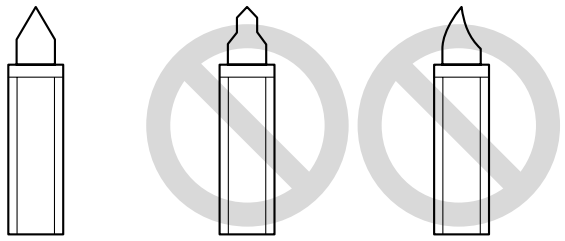
Specified positive pressure:
200.0 kPa (2.00 kgf/cm², 29.0 psi)

Checking the high-pressure fuel pump

1. Check the high-pressure fuel pump electrical performance. See “Checking the high-pressure fuel pump” (5-22).

Checking the vapor separator

1. Check the needle valve. Replace the needle valve assembly if bent or worn.

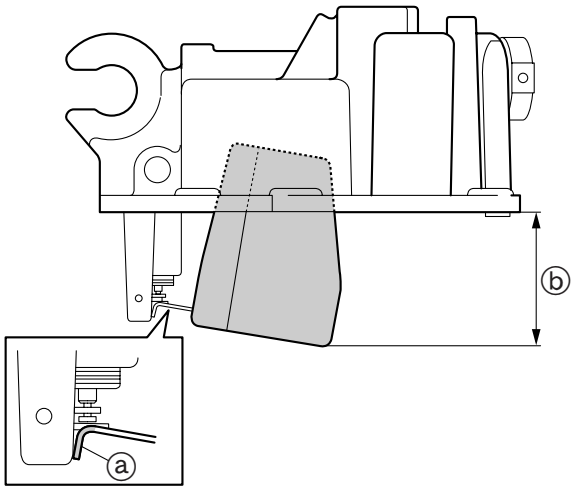


2. Check the float. Replace if there is deterioration.

3. Check the filter. Clean if there is dirt or residues.

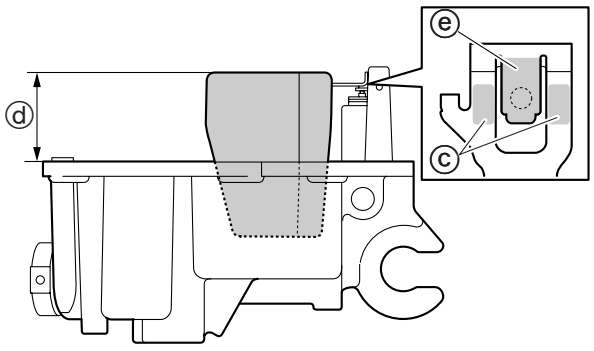
Adjusting the float height

1. Adjust the float height to the specified height ⓑ by bending ⓐ of the float.



Float height ⓑ:
42.1 ± 2.0 mm (1.66 ± 0.08 in)

2. Adjust the float height ⓓ to the specified height by bending ⓒ of the float.



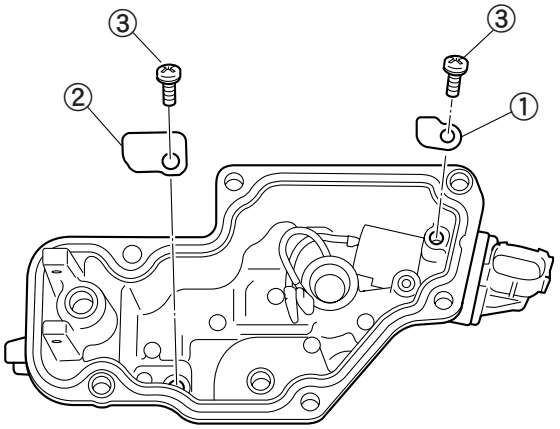
Float height ⓓ (reference data):
30.7 mm (1.21 in)

TIP:

- When adjusting the float height, do not bend the lever ⓔ.
- Bend both portions of ⓒ equally, when bending ⓒ of the float.

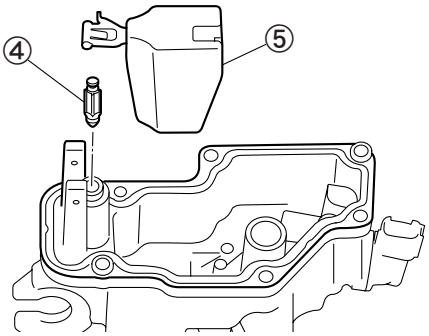
Assembling the vapor separator

1. Install the plates ① and ②, and then tighten the float chamber plate screws ③ to the specified torque.

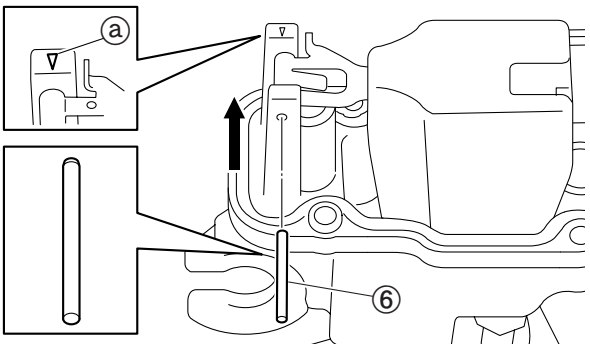


Float chamber plate screw ③:
2 N·m (0.2 kgf·m, 1.5 ft·lb)

2. Install the needle valve ④, the float ⑤, and the float pin ⑥.



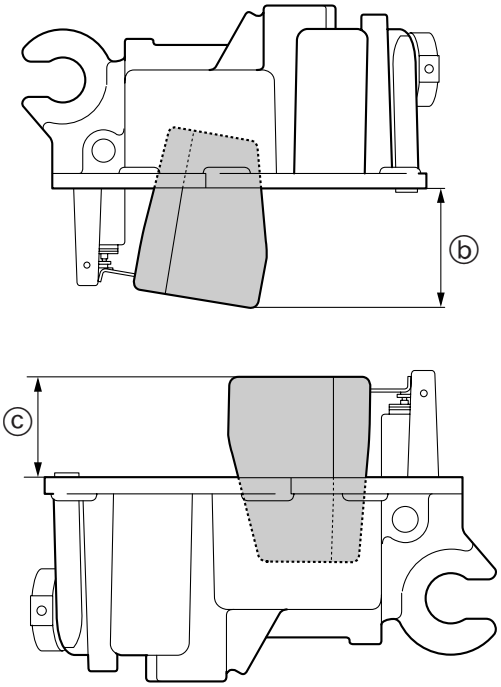
6



TIP:

- Do not reuse the float pin. Always replace it with a new one.
- Install the float pin with its tapered end facing towards the mark ⓐ on the float chamber cover.

3. Measure the float heights ⓑ and ⓒ. Adjust the float heights if out of specification.

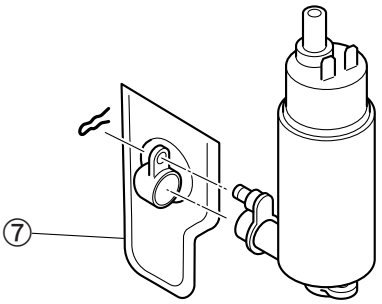


Float height ⓑ: 42.1 ± 2.0 mm (1.66 ± 0.08 in) Float height ⓒ (reference data): 30.7 mm (1.21 in)

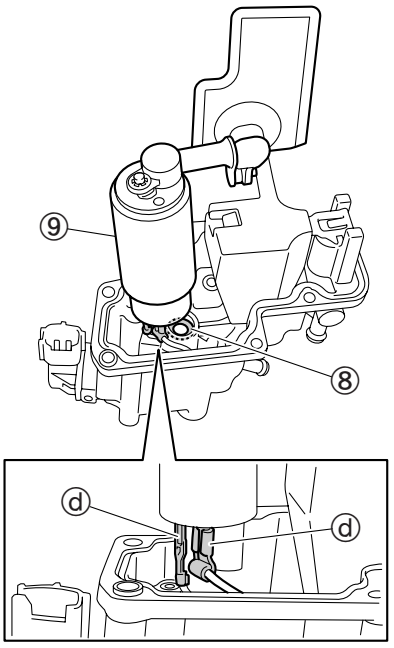
TIP:

The float should be resting on the needle valve when measuring the float height. Do not press the float.

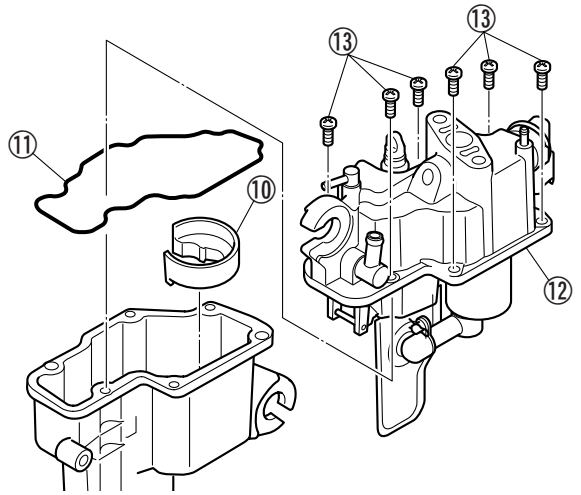
4. Install the filter ⑦.



5. Connect the high-pressure fuel pump connectors ⓓ, and then install a new O-ring ⑧ and the high-pressure fuel pump ⑨.



6. Install the filter holder ⑩, a new gasket ⑪, and the cover assembly ⑫, and then tighten the float chamber cover screws ⑬ to the specified torque.

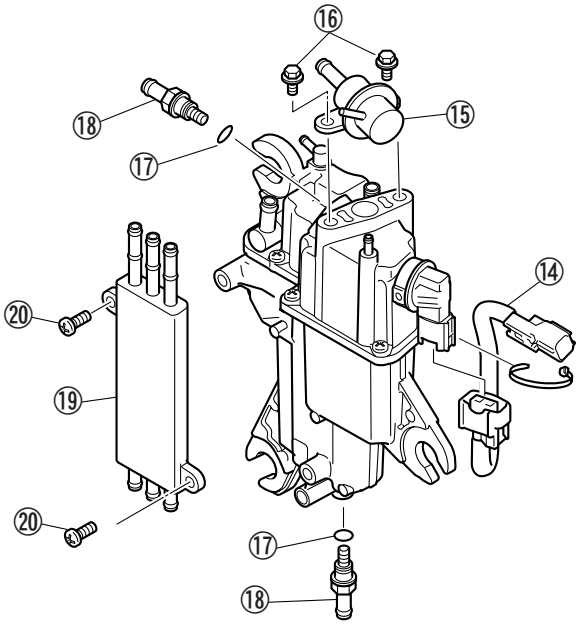


Float chamber cover screw ⑬: 3 N·m (0.3 kgf·m, 2.2 ft·lb)

7. Connect the lead ⑭.

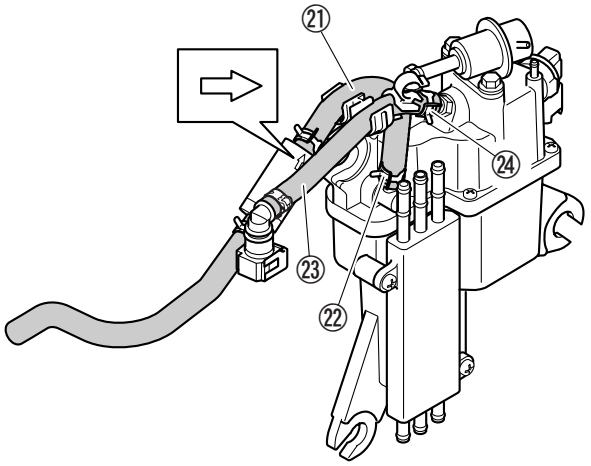
8. Install the pressure regulator ⑮, the pressure regulator bolts ⑯, new O-rings ⑰, and the nipples ⑱, and then tighten the pressure regulator bolts ⑯ and the nipple ⑱ to the specified torque.

9. Install the fuel cooler ⑲, and then tighten the fuel cooler screws ⑳ to the specified torque.

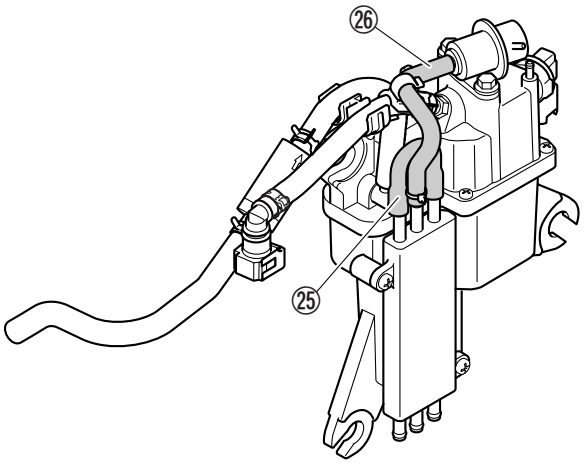


Pressure regulator bolts ⑯: 5 N·m (0.5 kgf·m, 3.7 ft·lb) Nipple ⑱: 4 N·m (0.4 kgf·m, 3.0 ft·lb) Fuel cooler screw ⑳: 3.5 N·m (0.35 kgf·m, 2.58 ft·lb)

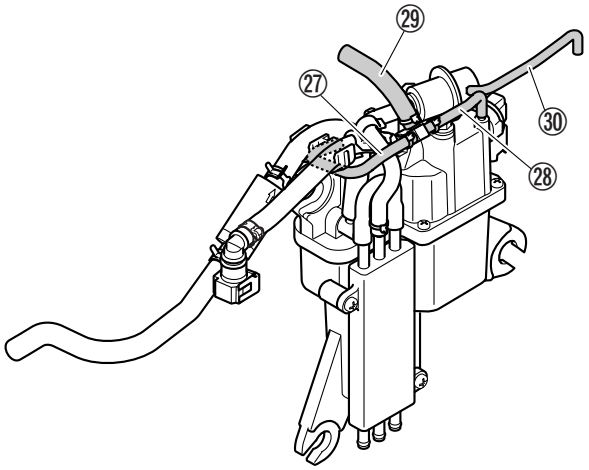
10. Install the fuel hose ㉑ with the clamp ㉒ and the fuel hose ㉓ with the clamp ㉔.



11. Install the cooling water hose ㉕ and the fuel hose ㉖.

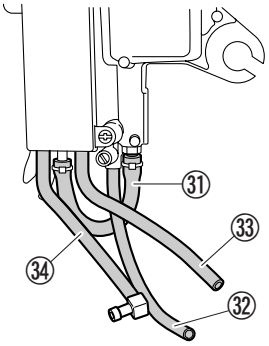


12. Install the vapor gas hoses ㉗, ㉘, ㉙ and the pressure regulator hose ㉚.

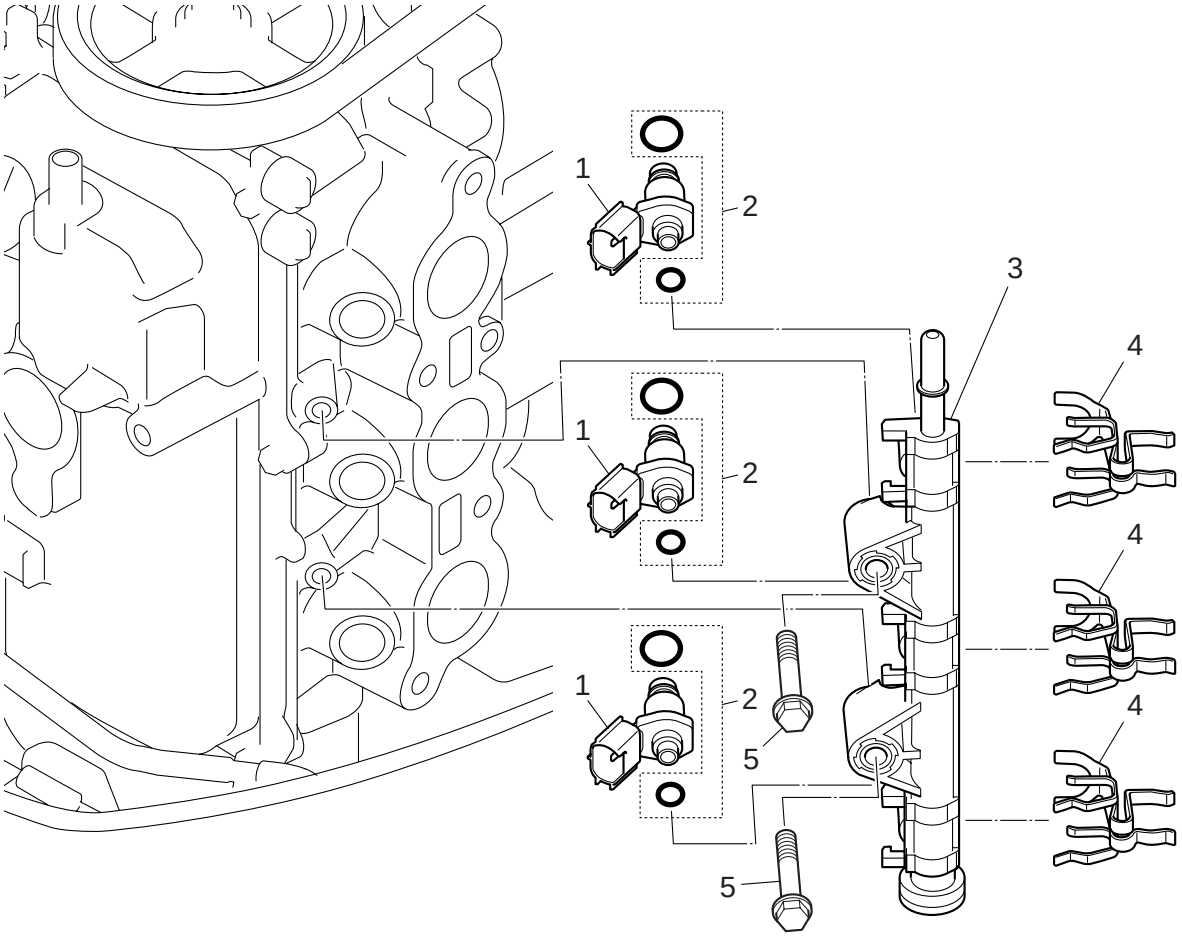


13. Install the fuel hose ㉛ and the drain hose ㉜.

14. Install the cooling water hoses ㉝ and ㉞.



Fuel injector

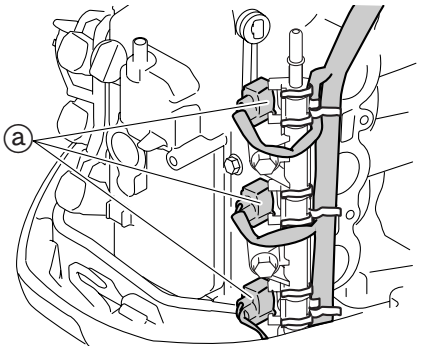


No.	Part name	Q'ty	Remarks
1	Fuel injector	3	
2	O-ring set	3	**Not reusable**
3	Fuel rail	1	
4	Holder	3	
5	Bolt	2	M6 × 40 mm

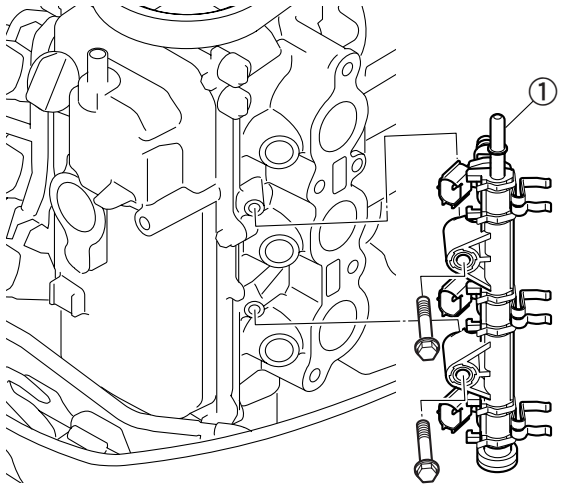
Removing the fuel injector

Use a rag to catch any spilled gasoline when removing the fuel components.

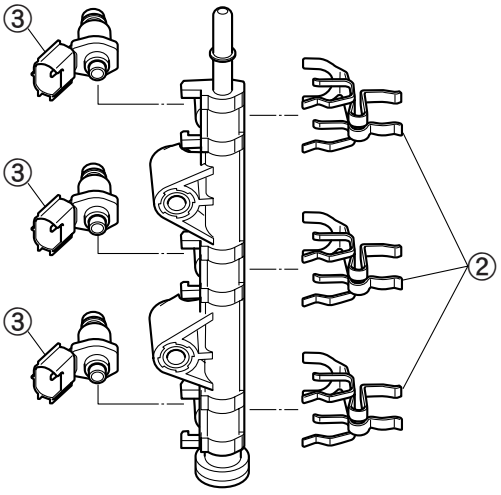
1. Disconnect the fuel injector coupler ⓐ.
2. Remove the wiring harness from the holder.



3. Remove the fuel rail assembly ①.



4. Remove the holders ② and the fuel injectors ③.

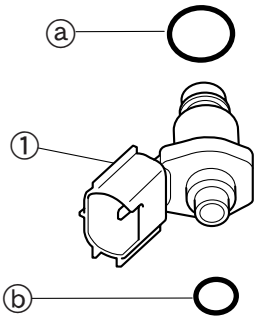


Checking the fuel rail

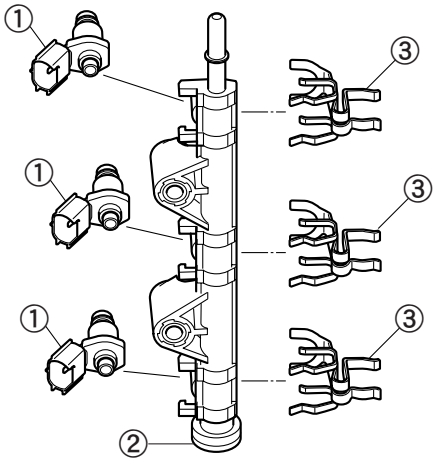
1. Check the fuel rail. Replace if cracked or deformed.
2. Check the fuel injectors. See “Checking the fuel injector” (5-21).

Installing the fuel injector

1. Install new O-rings ⓐ and ⓑ to the fuel injector ①.

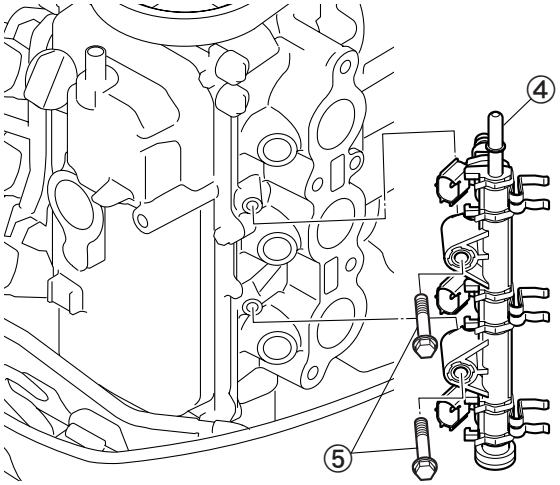


2. Install the fuel injectors ① onto the fuel rail ②, and then install the holders ③.

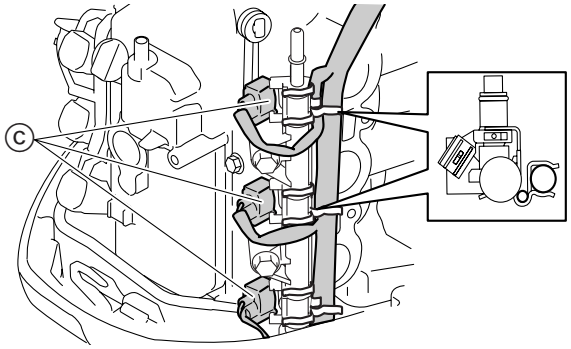


3. Install the fuel rail assembly ④ onto the cylinder head.

4. Tighten the bolts ⑤ equally and gradually.



5. Install the wiring harness to the holders, and then connect the fuel injector couplers ⓒ.



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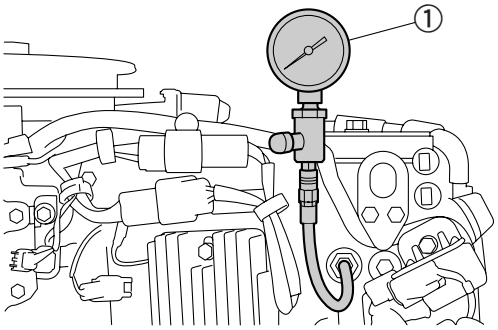
Power unit (check and adjustment)

Checking the compression pressure

1. Start the engine and warm it up for 5 minutes.
2. Remove the clip from the engine shut-off switch.
3. Remove all the spark plug caps from the spark plugs.
4. Remove all the spark plugs, and then install the special service tool ① into a spark plug hole. ***NOTICE:*** **Before removing the spark plugs, blow compressed air into the spark plug well to clear out any dirt or dust that may fall into the cylinder**.



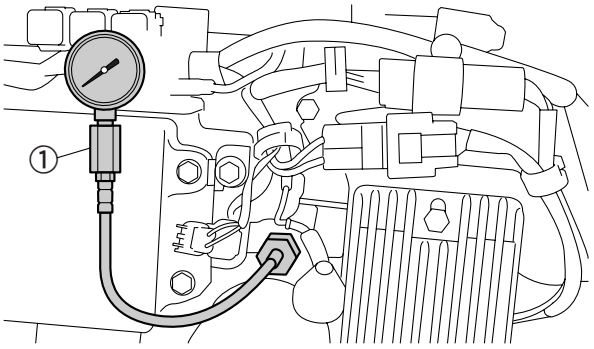
Compression gauge ①: 90890-03160

5. Fully open the throttle.
6. Crank the engine until the reading on the compression gauge stabilizes, and then check the compression pressure.

Minimum compression pressure (reference data):
840.0 kPa (8.40 kgf/cm², 121.8 psi)
at 20 °C (68 °F)

Checking the oil pressure

1. Disconnect the oil pressure switch lead at the oil pressure switch end.
2. Remove the oil pressure switch, and then install an oil pressure gauge ① to the oil pressure switch installation hole.
3. Start the engine and warm it up until the idle speed gets stable at 750–850 r/min.
4. Check the oil pressure.



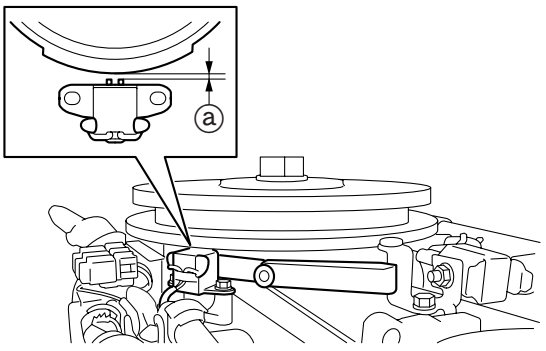
Oil pressure gauge ①:
(commercially available)

Oil pressure (reference data):
at 60 °C (140 °F) with SL 10W-30 engine oil and at 800 r/min:
230.0 kPa (2.30 kgf/cm², 33.4 psi)
at 61 °C (142 °F) with SL 10W-30 engine oil and at 3000 r/min:
480.0 kPa (4.80 kgf/cm², 69.6 psi)

TIP:
- Use a pressure gauge with an adapter that has a 1/8 pitch thread.
- The actual oil pressure may vary depending on the temperature and viscosity of the engine oil.

Checking the pulser coil air gap

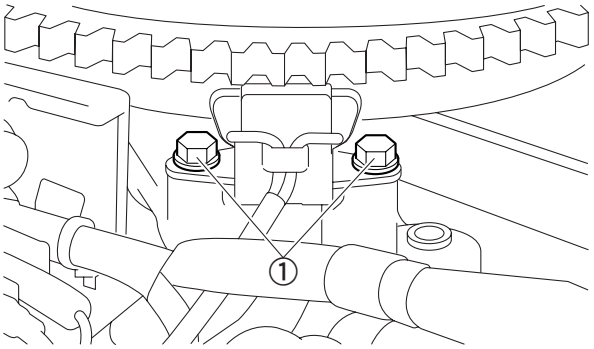
1. Turn the flywheel magnet clockwise to align the protrusion of the flywheel magnet with the pulser coil protrusion.
2. Measure the pulser coil air gap ⓐ. Adjust if out of specification.



Pulser coil air gap ⓐ:
0.35–1.35 mm (0.014–0.053 in)

Adjusting the pulser coil air gap

1. Loosen the pulser coil bolts ① and adjust the pulser coil air gap.



2. Tighten the pulser coil bolts ①, and then check the pulser coil air gap again.

Checking the valve clearance

Measure the valve clearances when the engine is cold.

NOTICE

Do not turn the flywheel magnet counter-clockwise. Otherwise, the water pump impeller may be damaged.

1. Remove the blowby hose ①, the fuel hoses ②, and the fuel filter assembly ③.

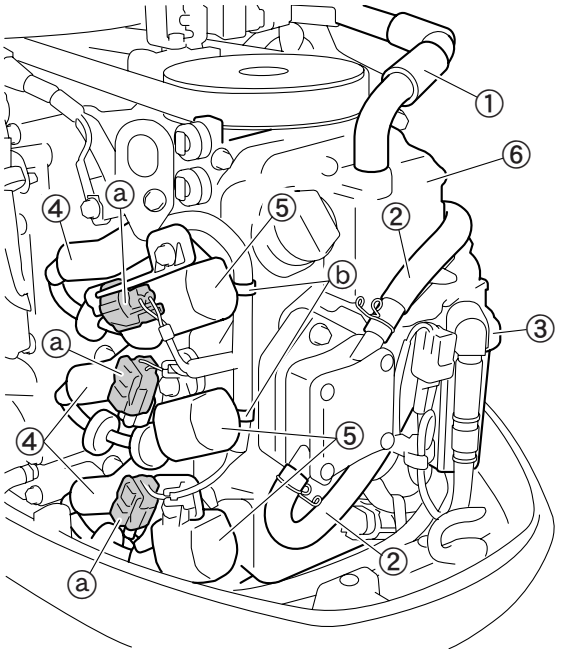
TIP:

Use a rag to catch any spilled gasoline when removing the fuel components.

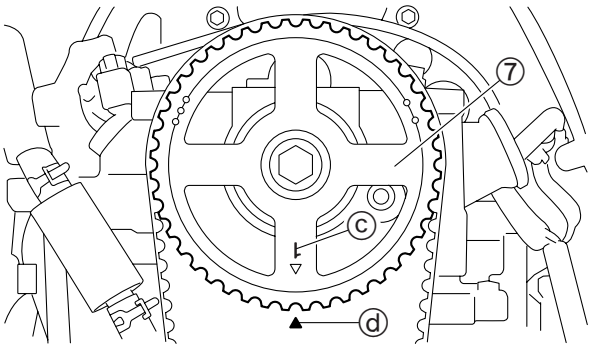
2. Remove all the spark plug caps ④ from the spark plugs.

3. Disconnect the ignition coil couplers ⓐ, and then remove the ignition coils ⑤.

4. Remove the clamps ⓑ from the cylinder head cover ⑥, and then remove the cylinder head cover ⑥.

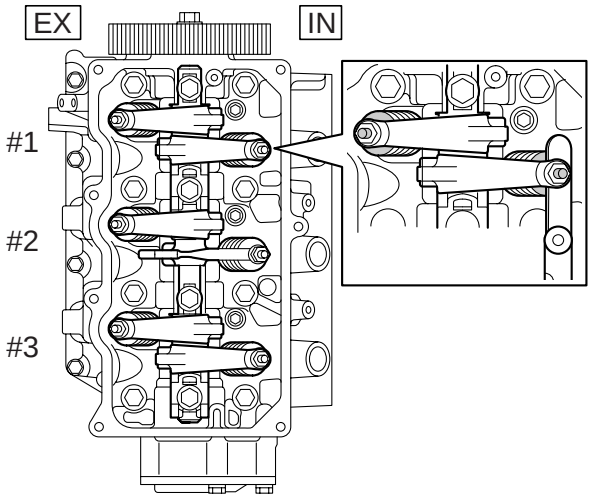


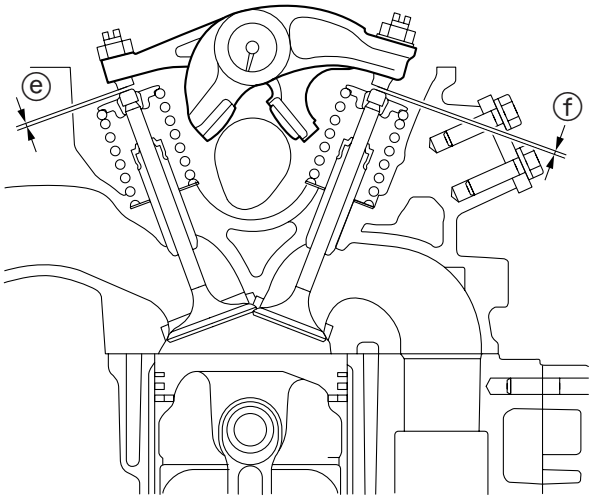
5. Turn the flywheel magnet clockwise and align the "1" mark ⓒ on the driven sprocket ⑦ with the "▲" mark ⓓ on the cylinder head.



7

6. Measure each valve clearance ⓔ and ⓕ following the step 7–step 12.





Valve clearance:
Intake ⓔ:
0.20 ± 0.05 mm (0.008 ± 0.002 in)
Exhaust ⓕ:
0.30 ± 0.05 mm (0.012 ± 0.002 in)

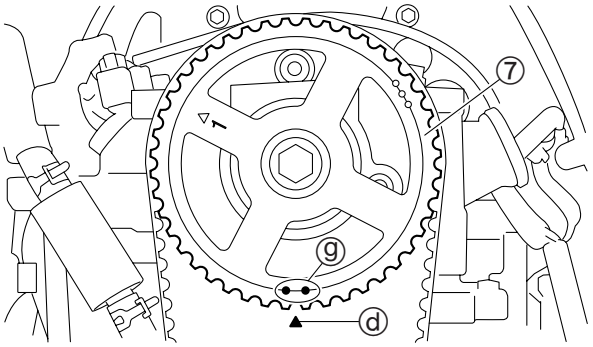
TIP:
Note down the measurement data.

7. Measure the intake and exhaust valve clearances of the corresponding cylinder.

	#1	#2	#3
IN	✓	—	—
EX	✓	—	—

—: Not applicable

8. Turn the flywheel magnet an additional 240° clockwise and align the "••" mark ⓖ on the driven sprocket ⑦ with the "▲" mark ⓓ on the cylinder head.

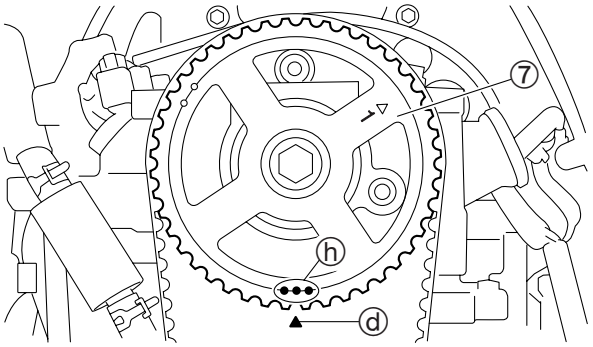


9. Measure the intake and exhaust valve clearances of the corresponding cylinder.

	#1	#2	#3
IN	—	✓	—
EX	—	✓	—

—: Not applicable

10. Turn the flywheel magnet an additional 240° clockwise and align the "•••" mark ⓗ on the driven sprocket ⑦ with the "▲" mark ⓓ on the cylinder head.



11. Measure the intake and exhaust valve clearances of the corresponding cylinder.

	#1	#2	#3
IN	—	—	✓
EX	—	—	✓

—: Not applicable

12. Adjust the valve clearances if out of specification.

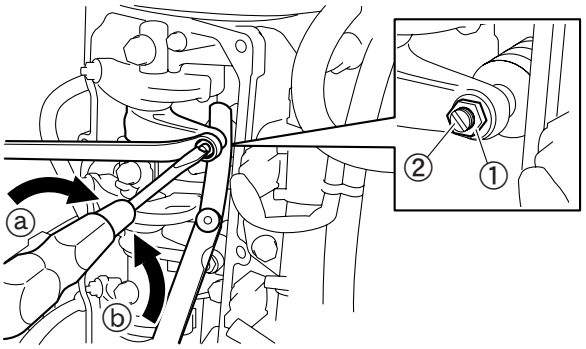
Adjusting the valve clearance

Adjust the valve clearances when the engine is cold.

NOTICE

Do not turn the flywheel magnet counterclockwise. Otherwise, the water pump impeller may be damaged.

1. Loosen the valve adjusting locknut ①, and then turn the adjusting screw ② until the specified valve clearance is obtained.



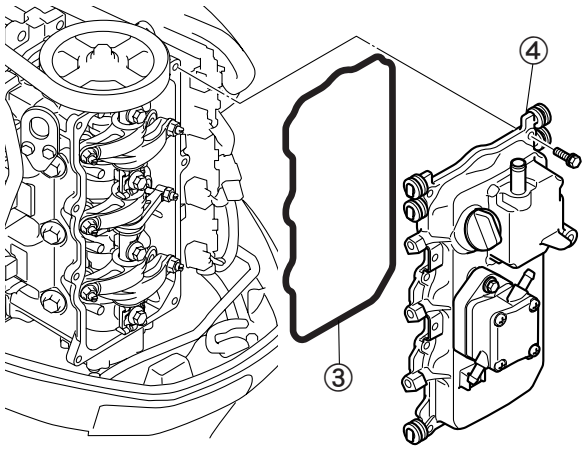
TIP:

- To decrease the valve clearance, turn the adjusting screw ② in direction ⓐ.
- To increase the valve clearance, turn the adjusting screw ② in direction ⓑ.

2. Tighten the valve adjusting locknut ① to the specified torque, and then check the valve clearances.

Valve adjusting locknut ①:
13.5 N·m (1.35 kgf·m, 9.96 ft·lb)

3. Install a new gasket ③ and the cylinder head cover ④.

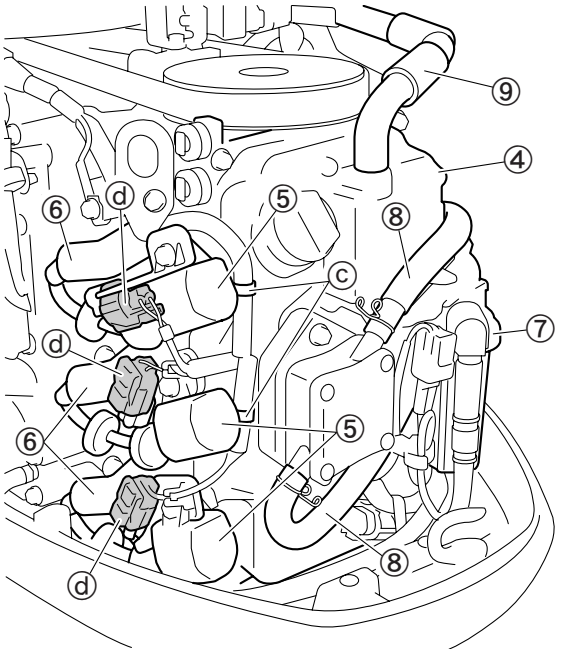


4. Install the clamps ⓒ to the cylinder head cover ④.

5. Install the ignition coils ⑤, and then connect the ignition coil couplers ⓓ.

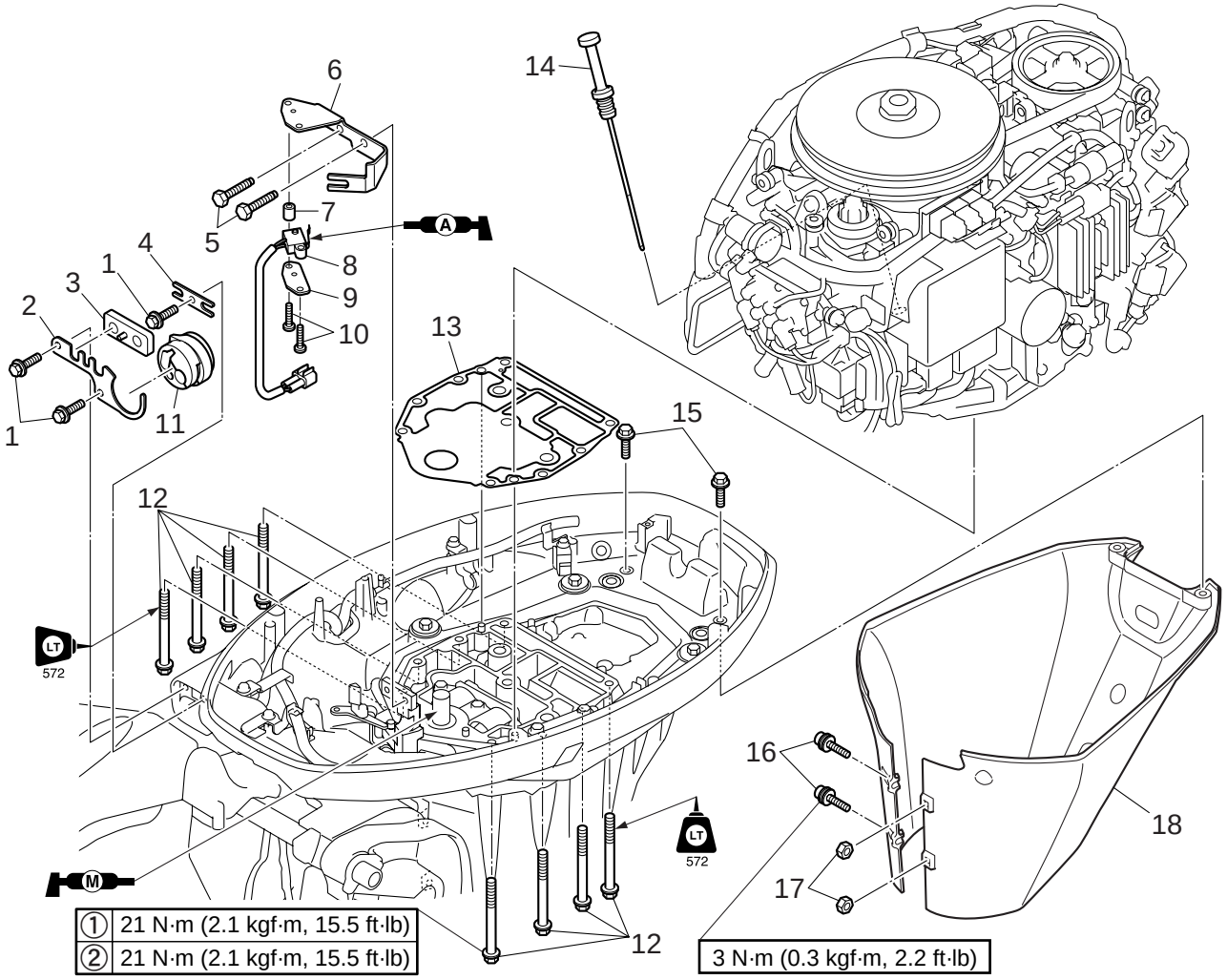
6. Install all the spark plug caps ⑥.

7. Install the fuel filter assembly ⑦, the fuel hoses ⑧, and the blowby hose ⑨.

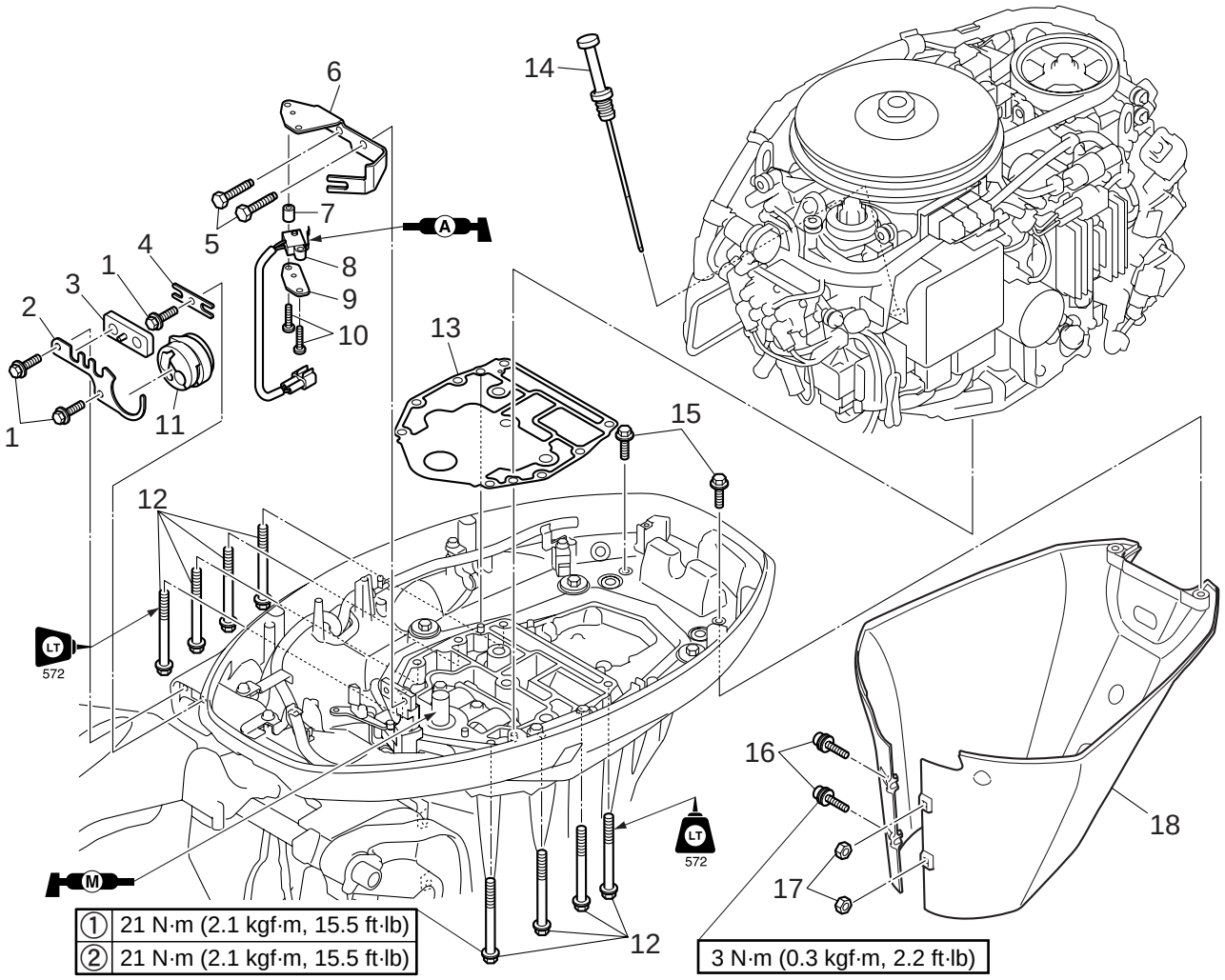


7

Power unit assembly



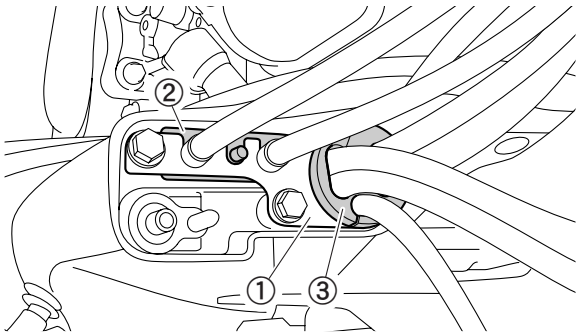
No.	Part name	Q'ty	Remarks
1	Bolt	3	M6 × 20 mm
2	Grommet holder	1	
3	Grommet	1	
4	Cable guide	1	
5	Bolt	2	M6 × 25 mm
6	Bracket	1	
7	Collar	1	
8	Neutral switch	1	
9	Plate	1	
10	Screw	2	M4 × 16 mm
11	Rigging grommet	1	
12	Bolt	8	M8 × 80 mm
13	Gasket	1	**Not reusable**
14	Dipstick	1	
15	Bolt	2	M6 × 16 mm
16	Screw	2	M6 × 25 mm
17	Nut	2	



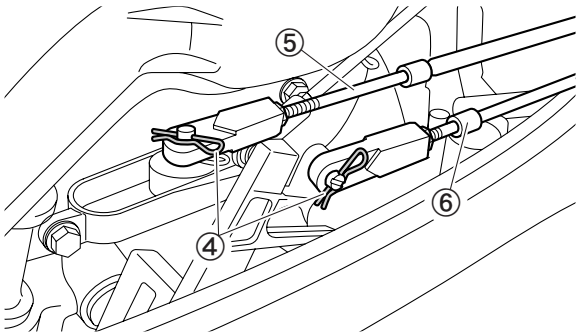
No.	Part name	Q'ty	Remarks
18	Apron	1	

Removing the power unit

1. Remove the grommet holder ①, the grommet ②, and the rigging grommet ③.



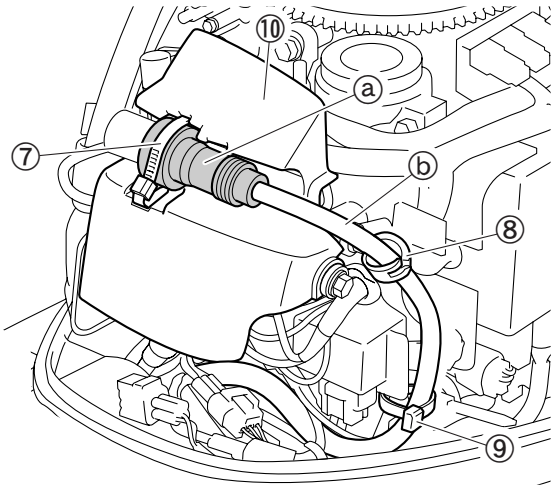
2. Remove the clips ④, and then disconnect the shift cable ⑤ and the throttle cable ⑥.



3. Remove the plastic tie ⑦, and then disconnect the 10-pin coupler ⓐ.

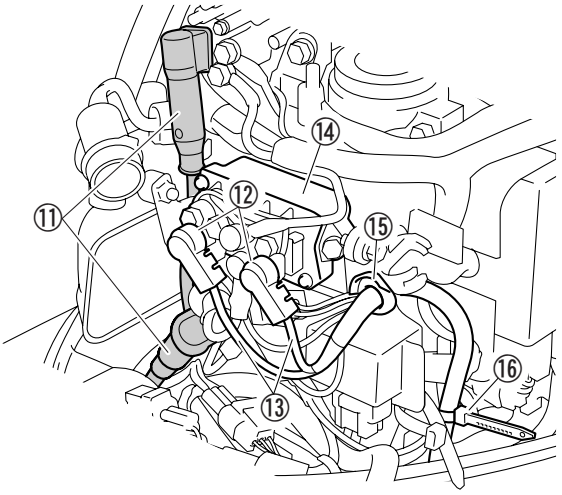
4. Remove the extension wiring harness ⓑ from the clamp ⑧ and the plastic tie ⑨.

5. Remove the cover ⑩.



6. Remove the battery cables ⑪.

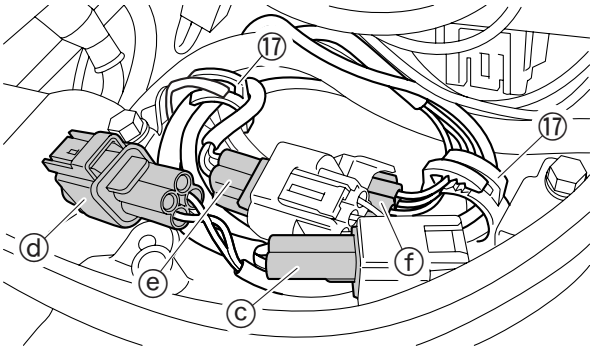
7. Remove the caps ⑫, and then remove the PTT motor leads ⑬ from the PTT relay ⑭, the clamp ⑮, and the plastic ties ⑯ (PTT model).



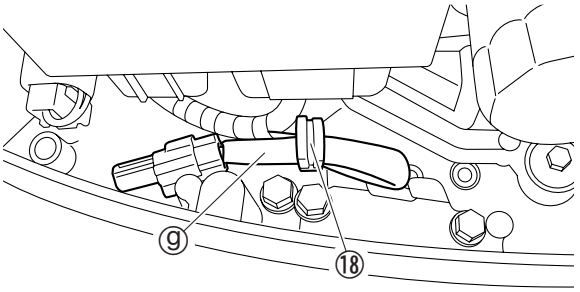
8. Disconnect the neutral switch coupler ⓒ and the 6Y8 Multifunction Meter harness coupler ⓓ.

9. Disconnect the trolling switch coupler ⓔ and the alert indicator coupler ⓕ (tiller handle model).

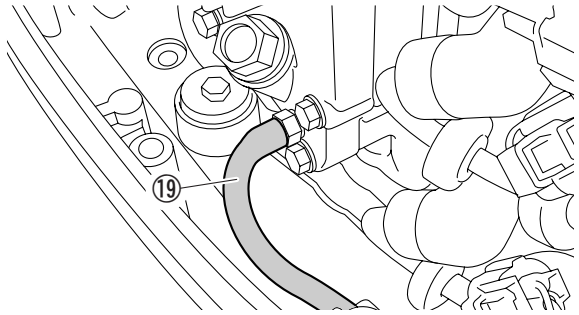
10. Remove the each harness from the clamps ⑰.



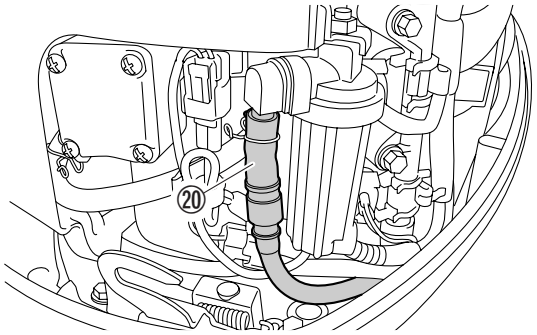
11. Remove the water pressure sensor harness ⓖ from the clamp ⑱.



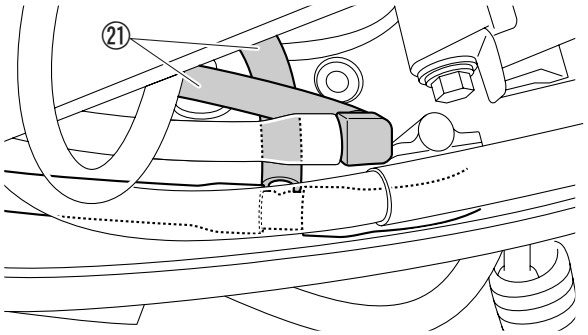
12. Remove the cooling water hose ⑲.



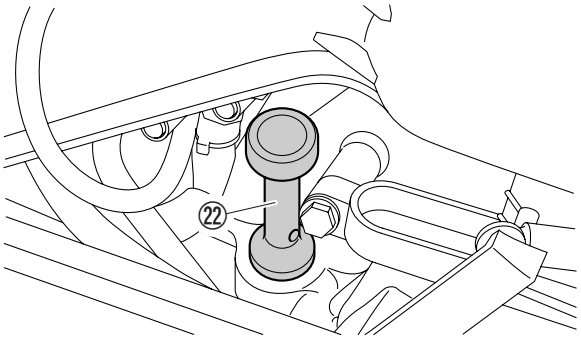
13. Remove the fuel hose ⑳.



14. Remove the cooling water hoses ㉑.

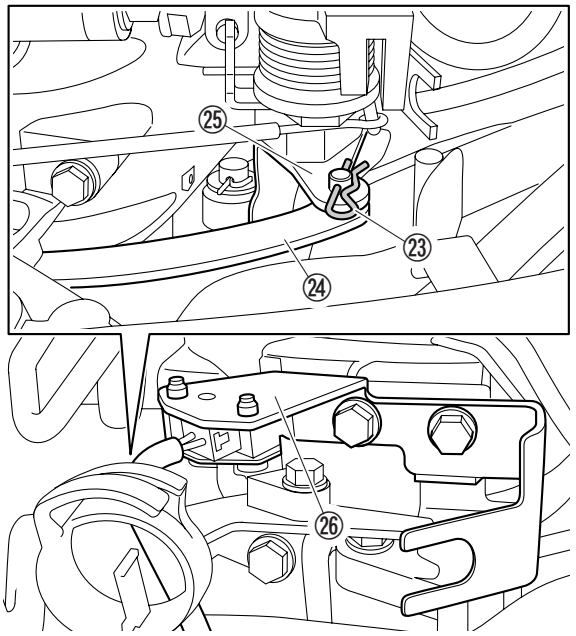


15. Remove the dipstick ㉒.

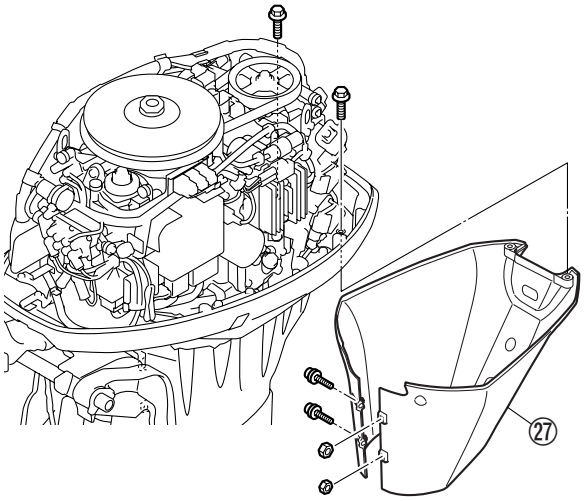


16. Remove the clip ㉓, and then remove the shift rod lever ㉔ from the shift rod bracket ㉕.

17. Remove the bracket ㉖.



18. Remove the apron ㉗.

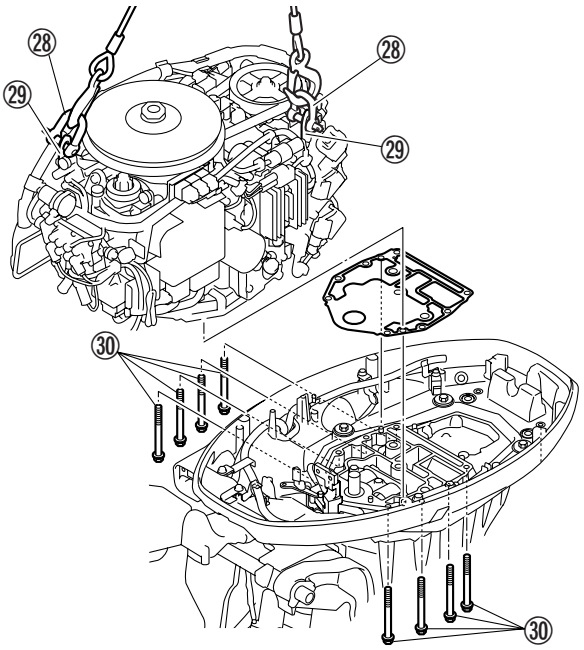


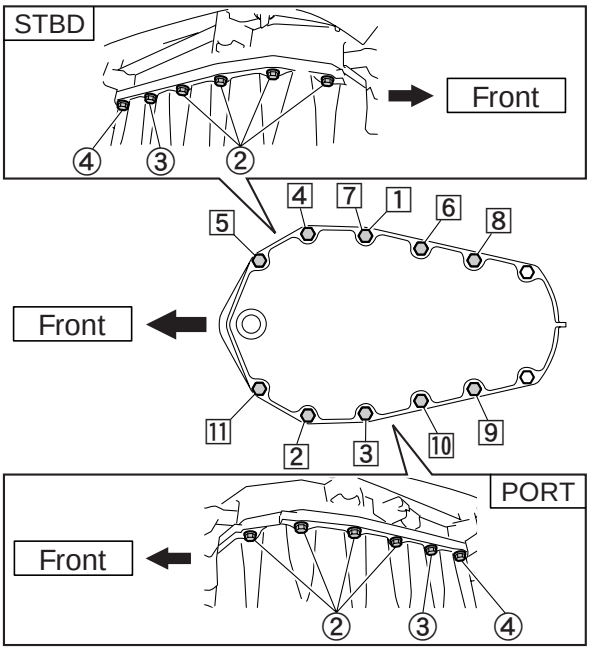
19. Install the shackles ㉘ to the engine hangers ㉙, and then install the lifting harnesses to the shackles ㉘.

20. Suspend the power unit.

21. Remove the power unit mounting bolts ㉚, and then remove the power unit.

7





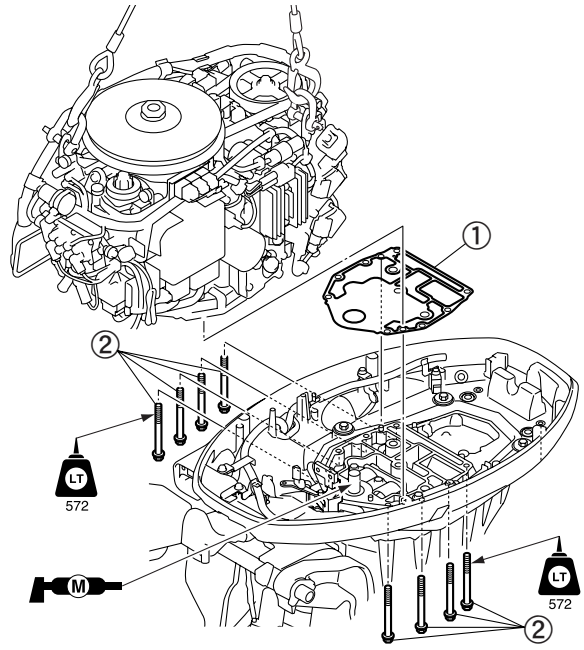
Installing the power unit

1. Clean the power unit mating surface, and then install a new gasket ①.

2. Install the power unit with the power unit mounting bolts ②.

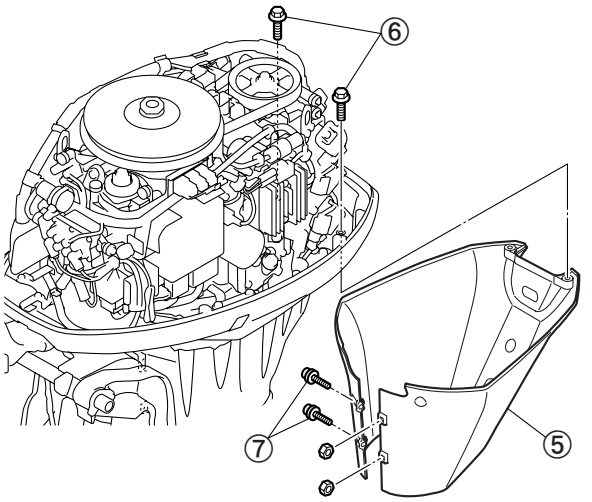
3. Tighten the power unit mounting bolts ② and the upper case bolts ③ to the specified torque in the sequence numbers (1, 2, · · ·) in both stages.

4. Tighten the upper case bolts ④ to the specified torque.



Power unit mounting bolt ②: 1st: 21 N·m (2.1 kgf·m, 15.5 ft·lb) 2nd: 21 N·m (2.1 kgf·m, 15.5 ft·lb) Upper case bolt ③: 1st: 21 N·m (2.1 kgf·m, 15.5 ft·lb) 2nd: 21 N·m (2.1 kgf·m, 15.5 ft·lb) Upper case bolt ④: 21 N·m (2.1 kgf·m, 15.5 ft·lb)

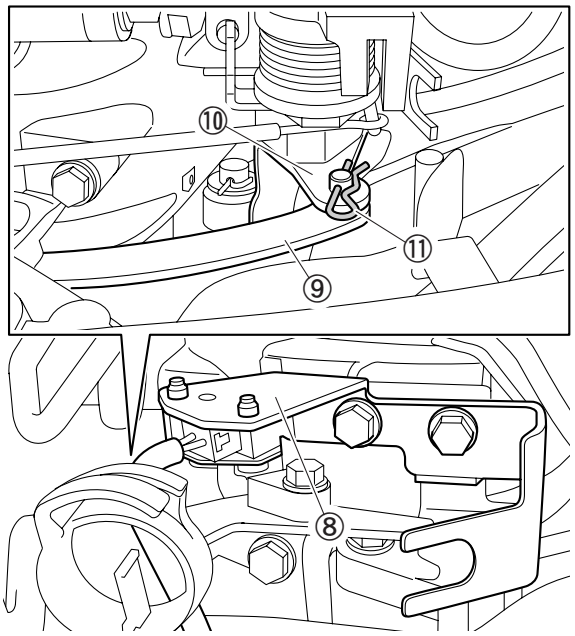
5. Install the apron ⑤ and the apron bolts ⑥, and then tighten the apron screws ⑦ to the specified torque.



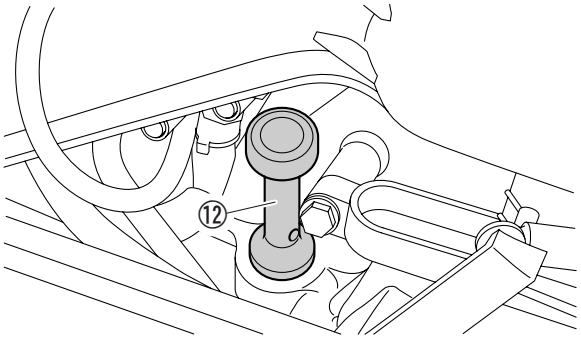
Apron screw ⑦: 3 N·m (0.3 kgf·m, 2.2 ft·lb)

6. Install the bracket ⑧.

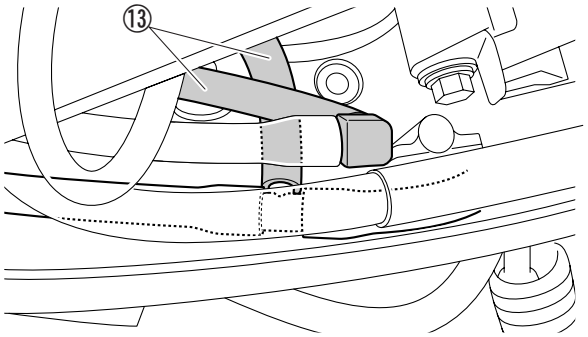
7. Install the shift rod lever ⑨ to the shift rod bracket ⑩, and then install the clip ⑪.



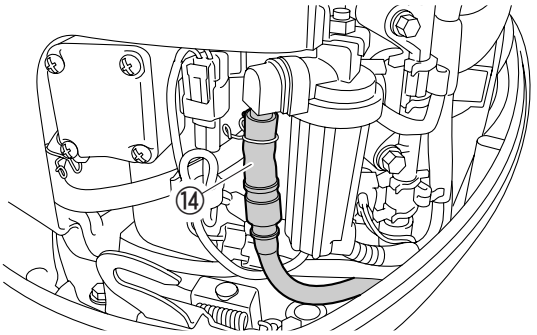
8. Install the dipstick ⑫.



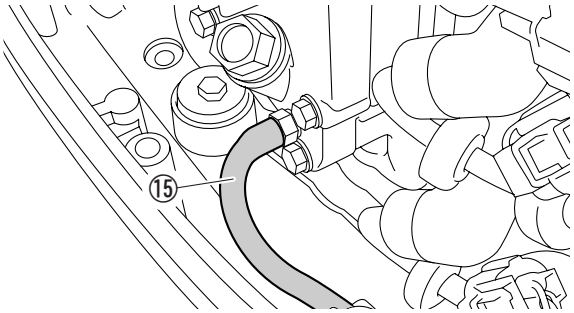
9. Install the cooling water hoses ⑬.



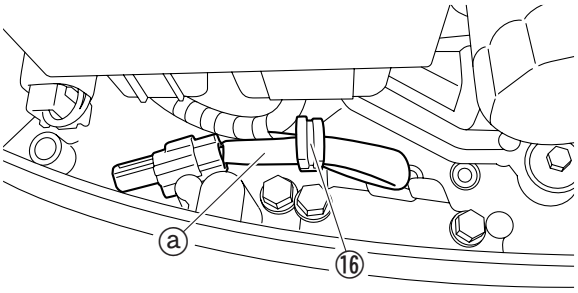
10. Install the fuel hose ⑭.



11. Install the cooling water hose ⑮.



12. Install the water pressure sensor harness ⓐ to the clamp ⑯.

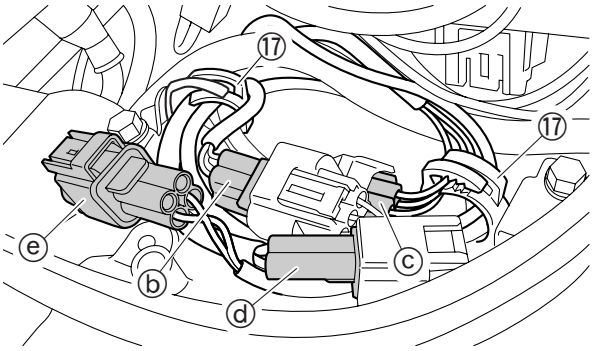


13. Connect the trolling switch coupler ⓑ and the alert indicator coupler ⓒ (tiller handle model).

14. Connect the neutral switch coupler ⓓ, and the 6Y8 Multifunction Meter harness coupler ⓔ.

15. Install the each harness to the clamps ⑰.

7

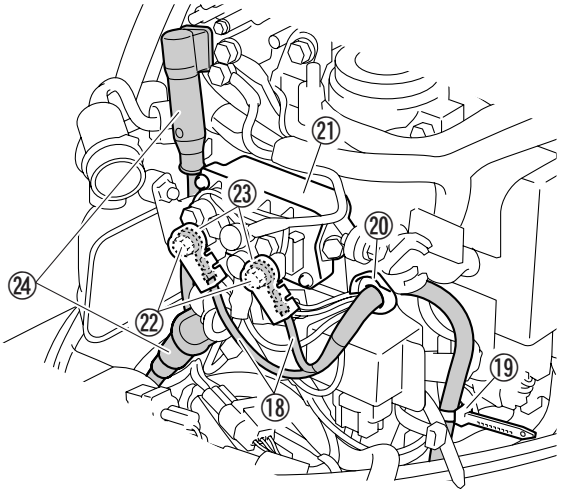


16. Install the PTT motor leads ⑱ to the plastic ties ⑲, the clamp ⑳, and the PTT relay ㉑ (PTT model).

17. Tighten the PTT motor lead bolts ㉒ to the specified torque (PTT model).

18. Install the caps ㉓ (PTT model).

19. Install the battery cables ㉔.

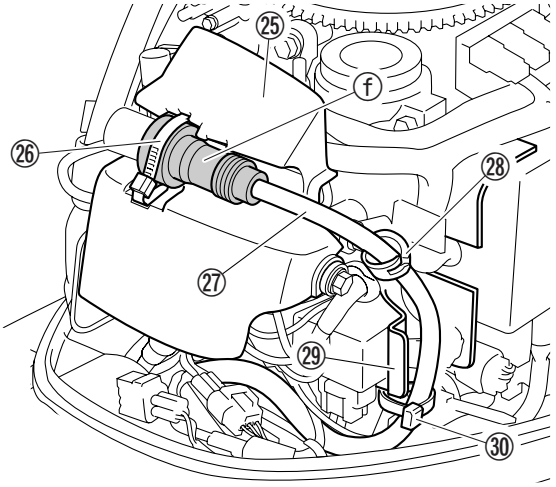


PTT motor lead bolt ㉒: 4 N·m (0.4 kgf·m, 3.0 ft·lb)

20. Install the cover ㉕.

21. Connect the 10-pin coupler ⓕ, and then fasten it to the cover ㉕ with a plastic tie ㉖.

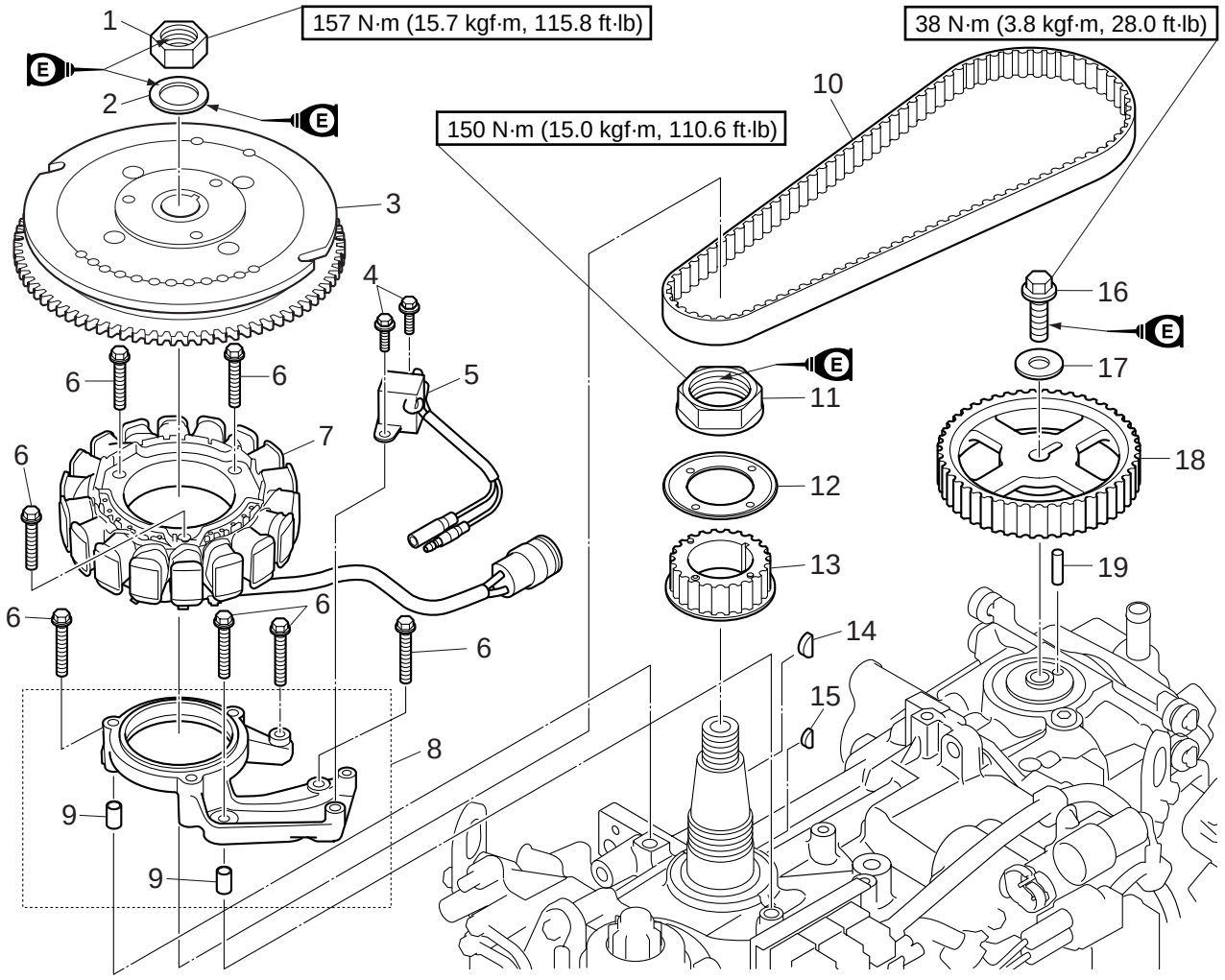
22. Install the extension wiring harness ㉗ to the clamp ㉘, and then fasten the extension wiring harness ㉗ to the bracket ㉙ with a plastic tie ㉚.



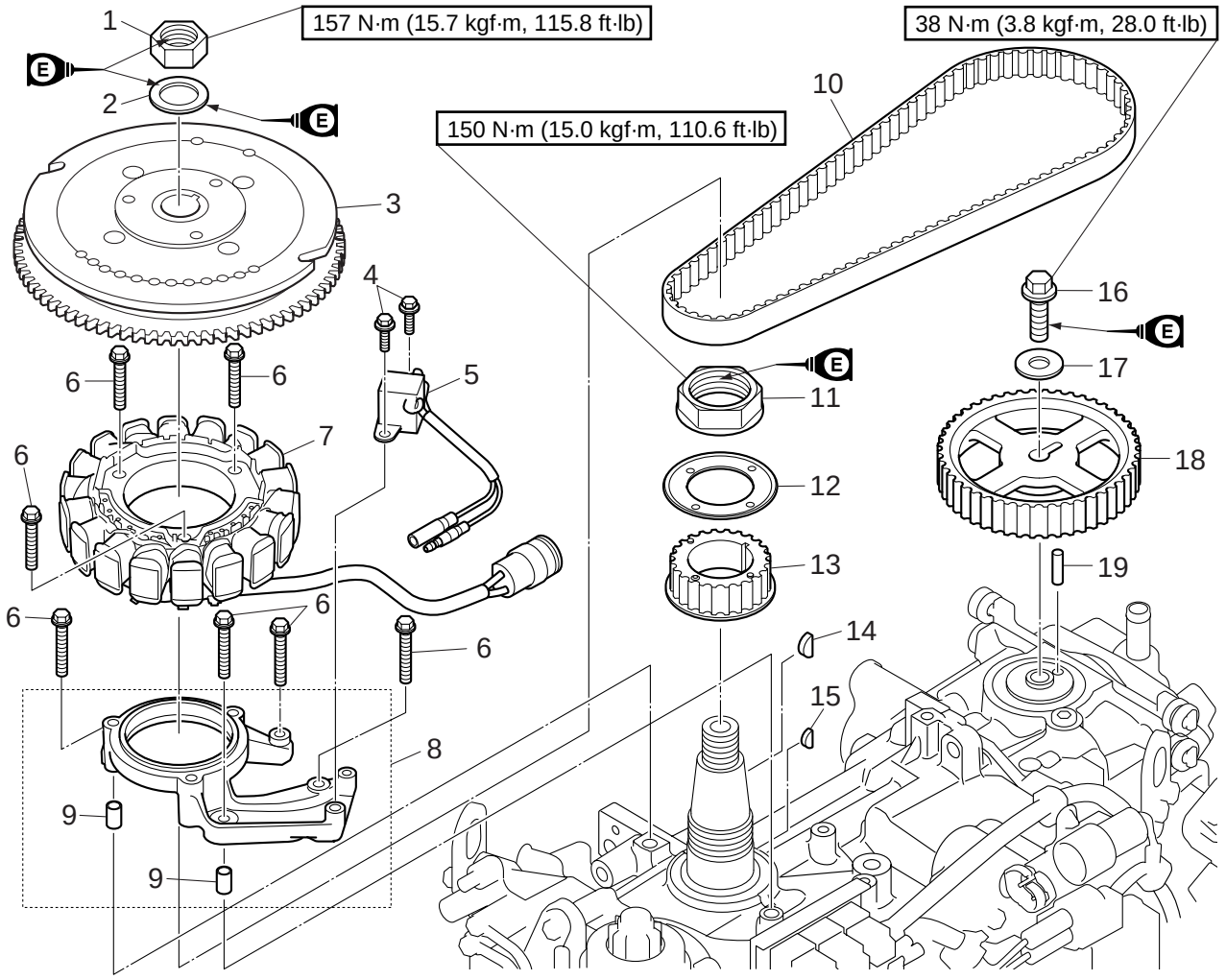
TIP:
Before fastening the extension wiring harness ㉗ to the clamp ㉘ and the bracket ㉙, pull it to prevent loosening.

23. Install the shift cable and the throttle cable. See “Installing the shift cable and throttle cable (remote control model)” (3-14).

Flywheel magnet and timing belt



No.	Part name	Q'ty	Remarks
1	Nut	1	Width across flats: 30 mm
2	Washer	1	
3	Flywheel magnet	1	
4	Bolt	2	M5 × 16 mm
5	Pulser coil	1	
6	Bolt	7	M6 × 30 mm
7	Stator assembly	1	
8	Base assembly	1	
9	Dowel	2	
10	Timing belt	1	
11	Nut	1	Width across flats: 41 mm
12	Retaining plate	1	
13	Drive sprocket	1	
14	Woodruff key	1	
15	Woodruff key	1	
16	Bolt	1	M10 × 35 mm
17	Washer	1	

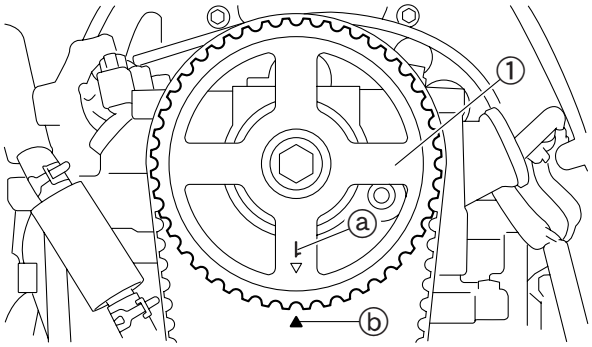


No.	Part name	Q'ty	Remarks
18	Driven sprocket	1	
19	Dowel	1	

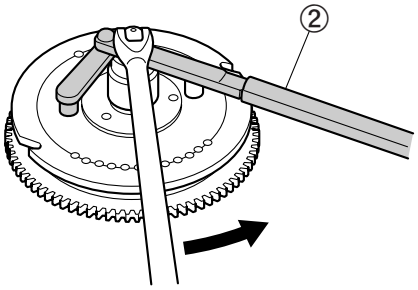
Removing the flywheel magnet

1. Remove the fuel system. See Chapter 6, "Fuel system."

2. Turn the flywheel magnet clockwise and align the "1" mark ⓐ on the driven sprocket ① with the "▲" mark ⓑ on the cylinder head.

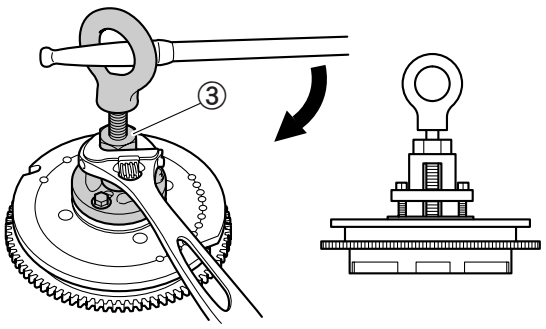


3. Loosen the flywheel magnet nut. ***NOTICE:*** **Apply force in the direction of the arrow to prevent the flywheel holder from slipping off easily.**



Flywheel holder ②: 90890-06522

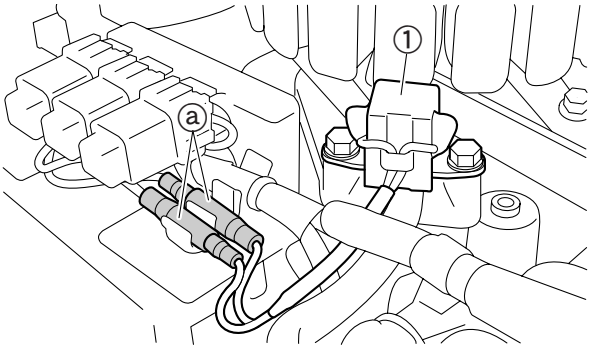
4. Remove the flywheel magnet and the Woodruff key. ***NOTICE:*** **To prevent damage to the engine or tools, screw in the flywheel puller set bolts evenly and completely so that the flywheel puller is parallel to the flywheel magnet.**



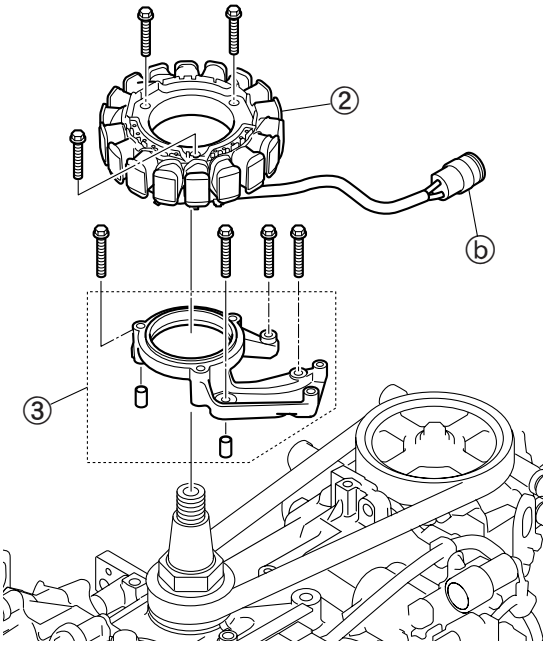
Flywheel puller ③: 90890-06521

Removing the stator assembly

1. Disconnect the pulser coil connectors ⓐ, and then remove the pulser coil ①.



2. Disconnect the stator assembly coupler ⓑ, and then remove the stator assembly ② and the base assembly ③.



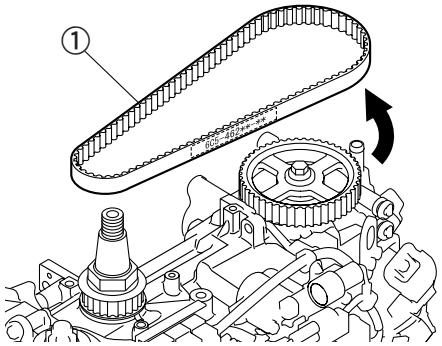
Removing the timing belt and sprocket

NOTICE

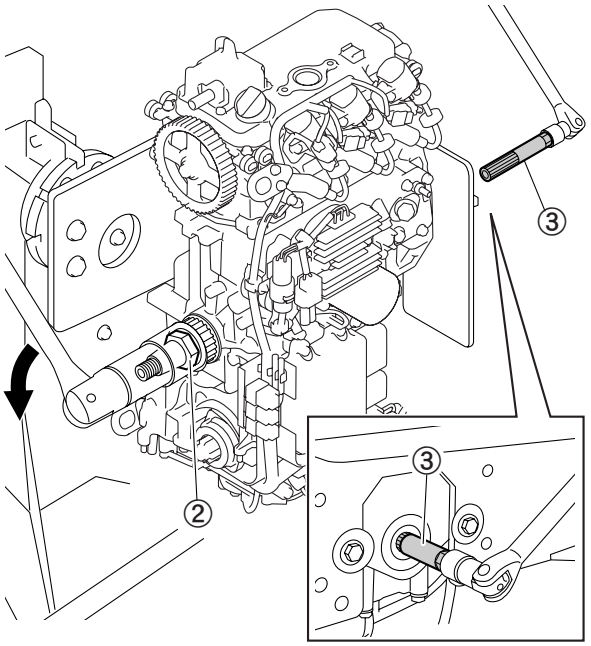
Do not turn the crankshaft or the driven sprocket when the timing belt is not installed. Otherwise, the piston and valves could collide with each other and be damaged.

1. Remove the timing belt ① from the driven sprocket side.

7



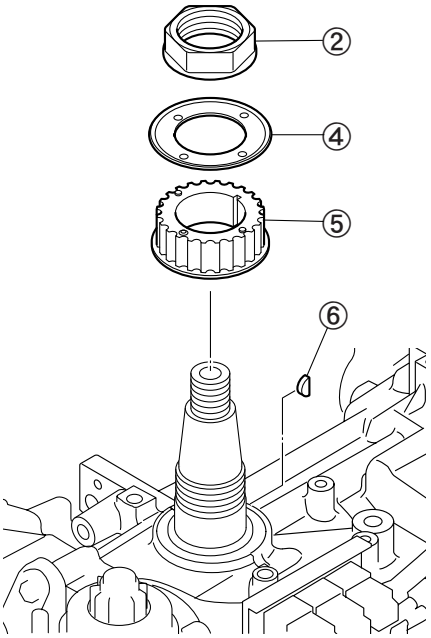
2. Loosen the drive sprocket nut ②.



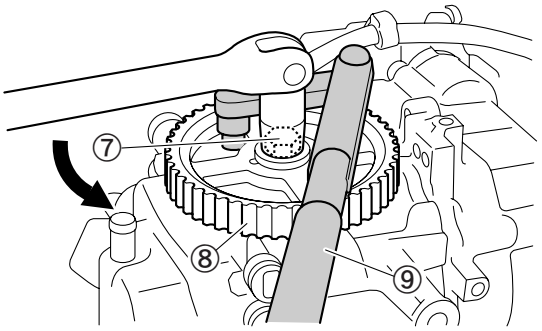
Crankshaft holder 16 ③: 90890-06355

TIP:
Use the air tool to loosen the drive sprocket nut easily.

3. Remove the drive sprocket nut ②, the retaining plate ④, the drive sprocket ⑤, and the Woodruff key ⑥.



4. Loosen the driven sprocket bolt ⑦, and then remove the driven sprocket ⑧. ***NOTICE:*** **Do not turn the camshaft when loosening the driven sprocket bolt**.



Flywheel holder ⑨: 90890-06522

Checking the timing belt and sprocket

1. Check the interior and exterior of the timing belt. Replace if cracked, damaged, or worn.

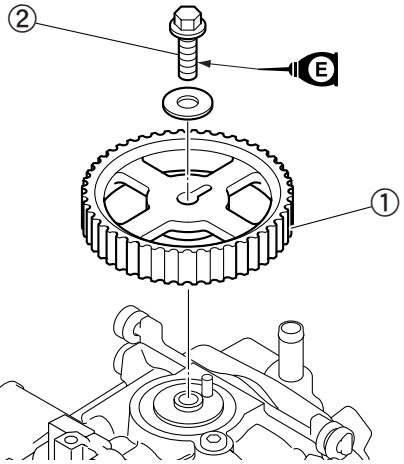
2. Check the drive sprocket and the driven sprocket. Replace if cracked, damaged, or worn.

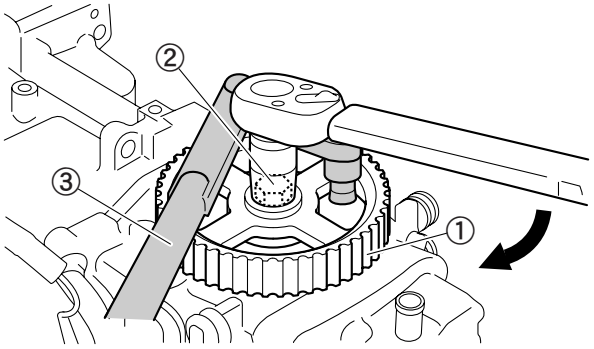
Installing the sprocket and timing belt

NOTICE

Do not turn the crankshaft or the driven sprocket when the timing belt is not installed. Otherwise, the piston and valves could collide with each other and be damaged.

1. Install the driven sprocket ①, and then tighten the driven sprocket bolt ② to the specified torque.

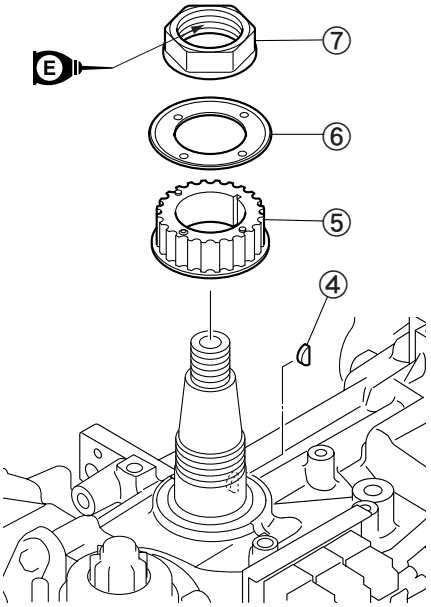




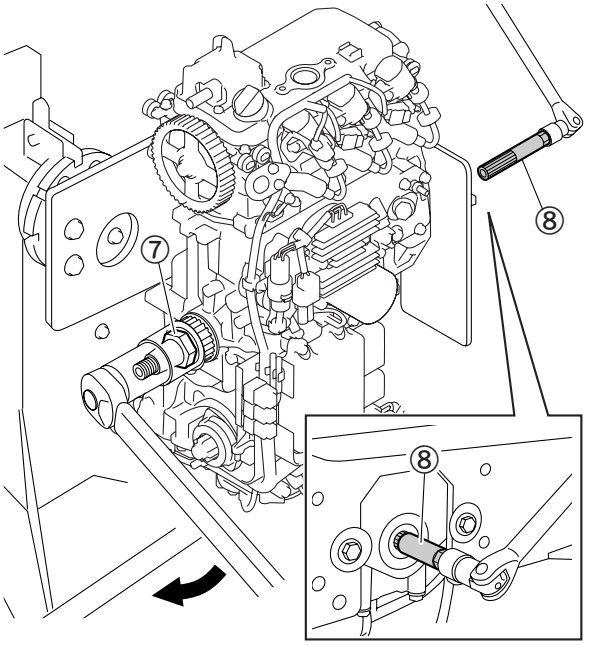
Flywheel holder ③: 90890-06522

Driven sprocket bolt ②:
38 N·m (3.8 kgf·m, 28.0 ft·lb)

2. Install the Woodruff key ④, the drive sprocket ⑤, the retaining plate ⑥, and the drive sprocket nut ⑦.



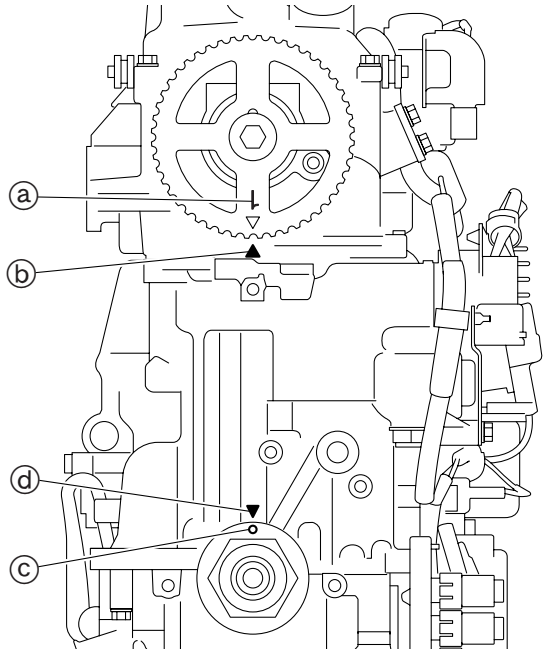
3. Tighten the drive sprocket nut ⑦ to the specified torque.



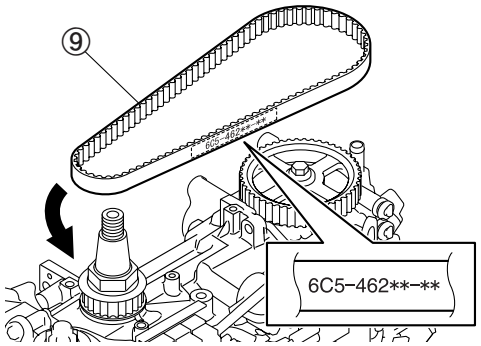
Crankshaft holder 16 ⑧: 90890-06355

Drive sprocket nut ⑦:
150 N·m (15.0 kgf·m, 110.6 ft·lb)

4. Check that the "1" mark ⓐ on the driven sprocket is aligned with the "▲" mark ⓑ on the cylinder head, and the hole ⓒ on the retaining plate is aligned with the "▲" mark ⓓ on the cylinder block.

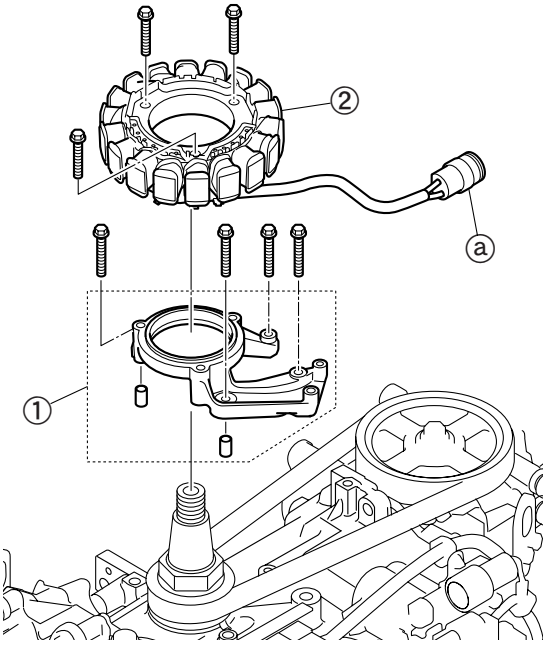


5. Install the timing belt ⑨ with its part number in the upright position.

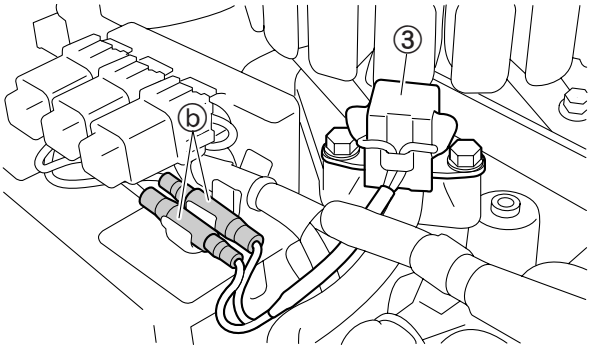


Installing the stator assembly

1. Install the base assembly ① and the stator assembly ②, and then connect the stator assembly coupler ⓐ.

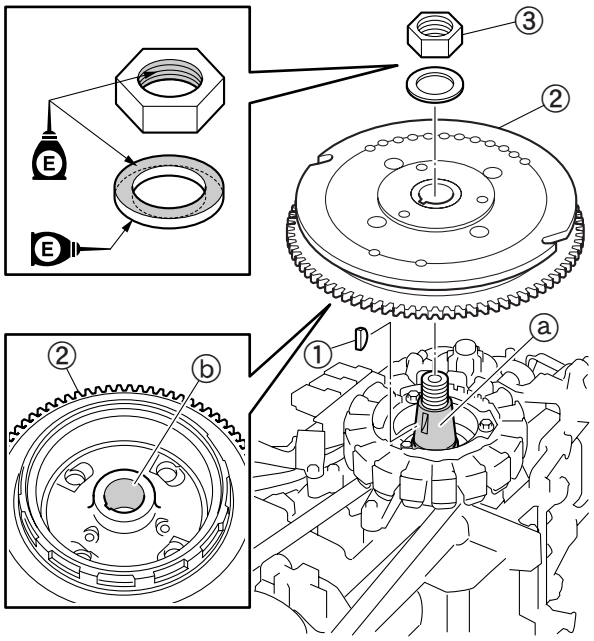


2. Install the pulser coil ③, and then connect the pulser coil connectors ⓑ.



Installing the flywheel magnet

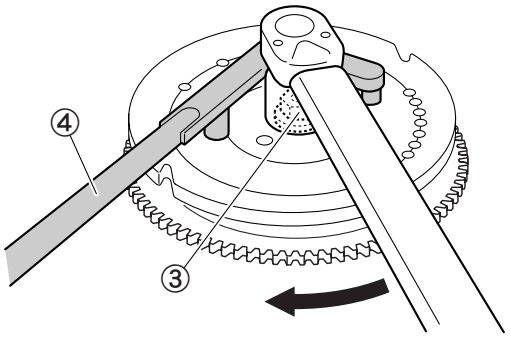
1. Install the Woodruff key ①, and then install the flywheel magnet ② and the flywheel magnet nut ③.



TIP:

Make sure to remove any grease from the tapered portion of the crankshaft ⓐ and the flywheel magnet ⓑ.

2. Tighten the flywheel magnet nut ③ to the specified torque. ***NOTICE:*** **Apply force in the direction of the arrow to prevent the flywheel holder from slipping off easily.**

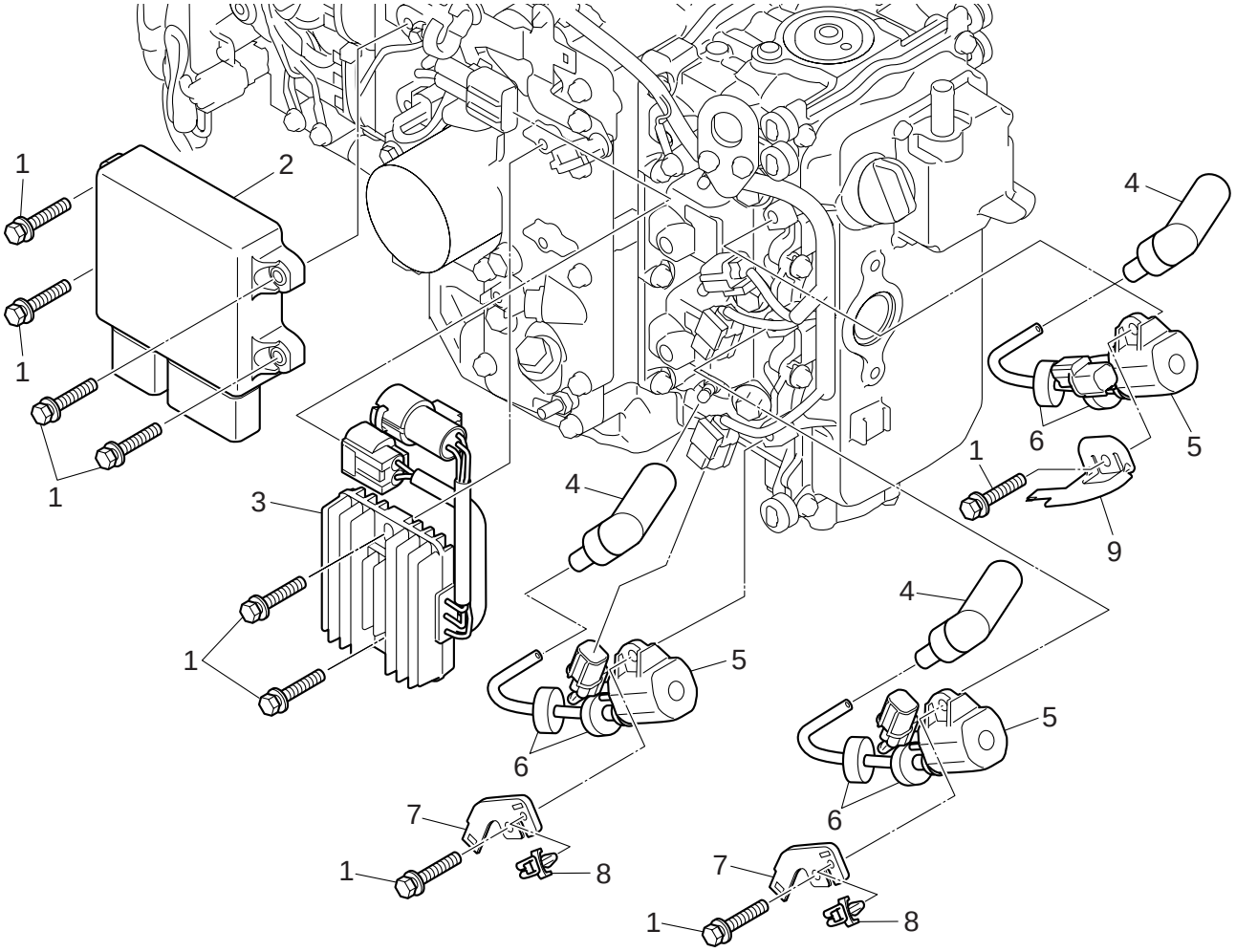


Flywheel holder ④: 90890-06522

Flywheel magnet nut ③: 157 N·m (15.7 kgf·m, 115.8 ft·lb)

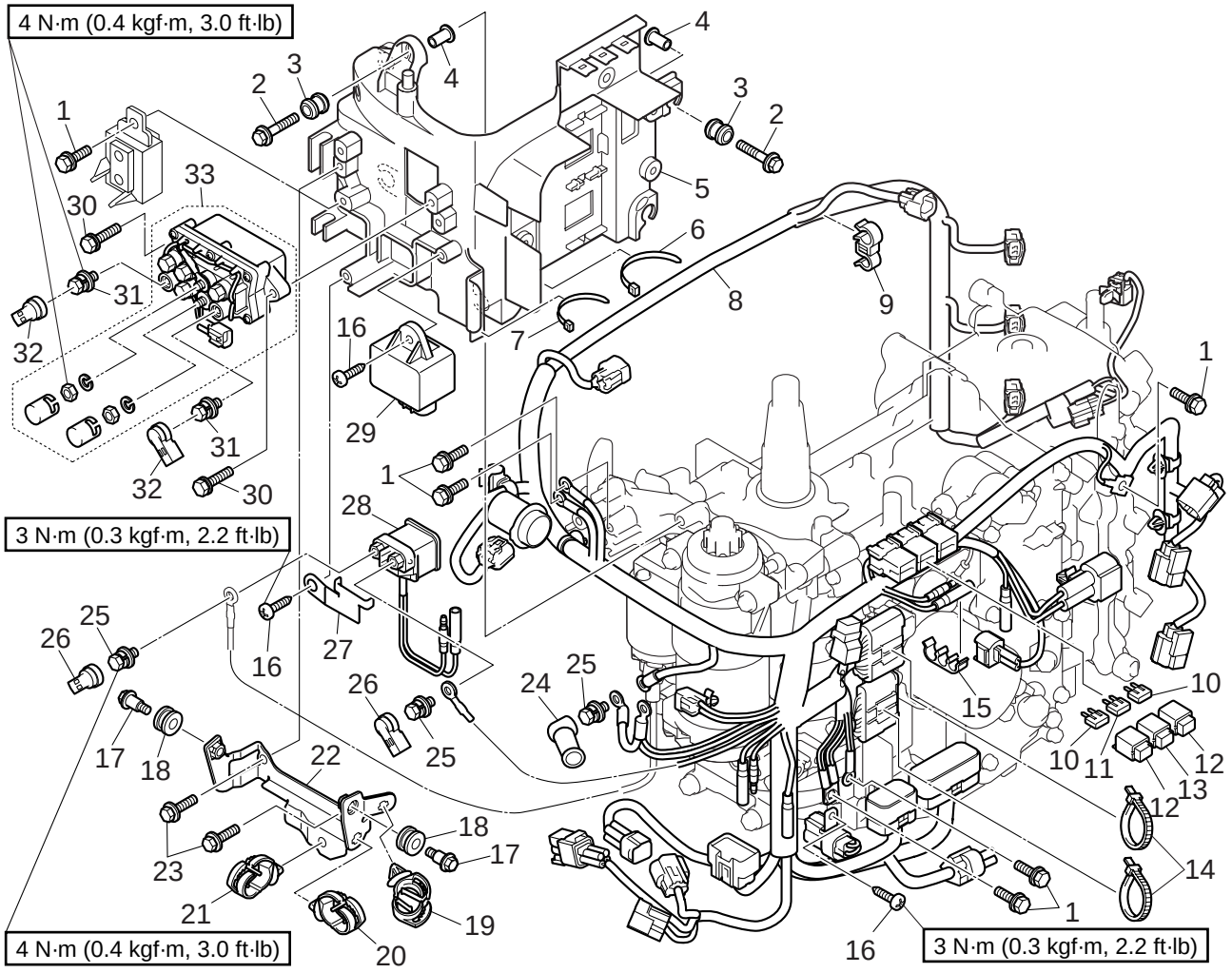
7

Engine ECM

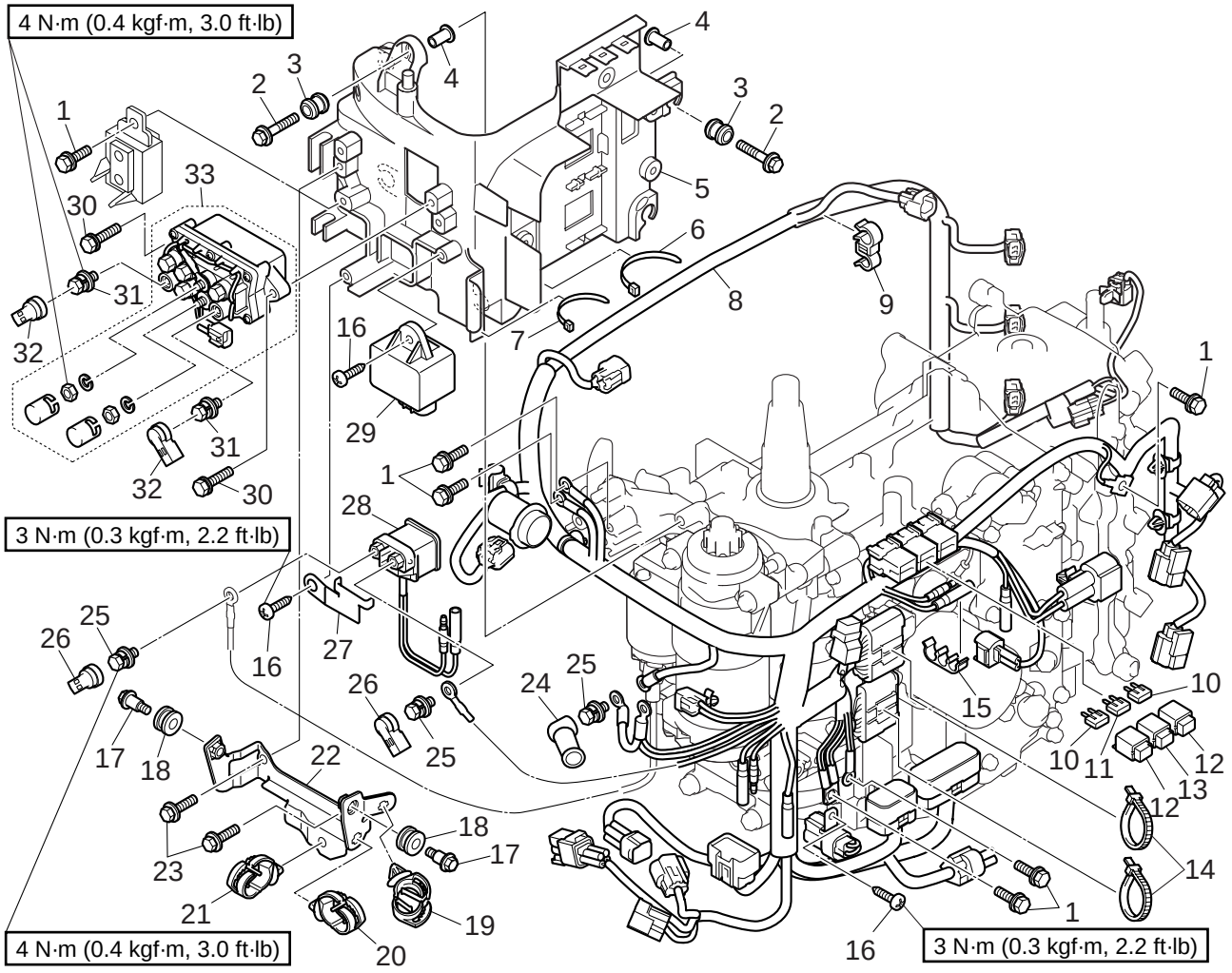


No.	Part name	Q'ty	Remarks
1	Bolt	9	M6 × 25 mm
2	Engine ECM	1	
3	Rectifier Regulator	1	
4	Spark plug cap	3	
5	Ignition coil	3	
6	Grommet	6	
7	Plate	2	
8	Clamp	2	
9	Plate	1	

Wiring harness



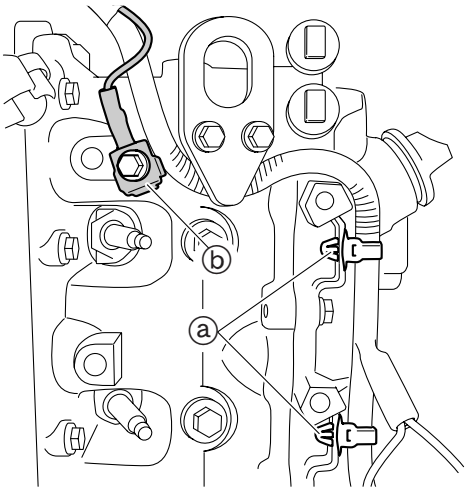
No.	Part name	Q'ty	Remarks
1	Bolt	6	M6 × 16 mm
2	Bolt	6	M6 × 28 mm
3	Grommet	6	
4	Collar	6	
5	Bracket	1	
6	Plastic tie	1	
7	Plastic tie	1	
8	Wiring harness	1	
9	Holder	1	
10	Fuse	4	20A
11	Fuse	2	30A
12	Cap	2	Yellow
13	Cap	1	Green
14	Plastic tie	2	
15	Holder	1	
16	Screw	3	ø6 × 20 mm
17	Bolt	2	



No.	Part name	Q'ty	Remarks
18	Grommet	2	
19	Clamp	1	
20	Clamp	1	
21	Clamp	1	Hydro tilt model
22	Bracket	1	
23	Bolt	2	M6 × 16 mm
24	Cap	1	
25	Bolt	3	M6 × 10 mm
26	Cap	2	
27	Plate	1	
28	Starter relay	1	
29	Main relay	1	
30	Bolt	2	M6 × 20 mm
31	Bolt	2	M6 × 10 mm, PTT model
32	Cap	2	PTT model
33	PTT relay	1	

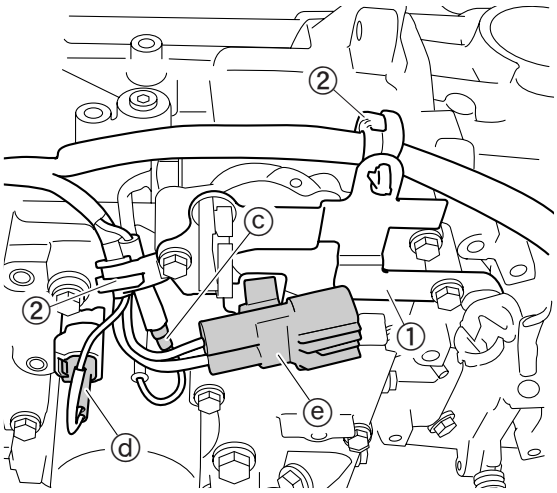
Removing the wiring harness

1. Remove the clamps ⓐ and the ground lead ⓑ.

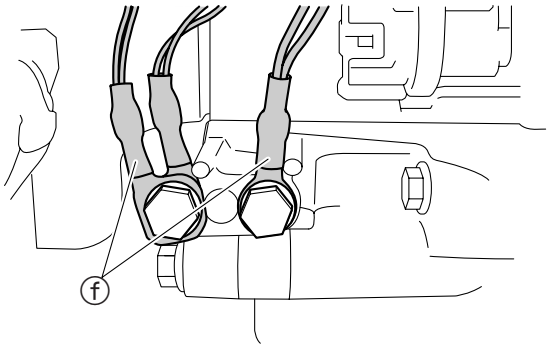


2. Disconnect the oil pressure switch connector ⓒ and the thermo sensor coupler ⓓ, and then remove the Rectifier Regulator coupler ⓔ from the bracket ①.

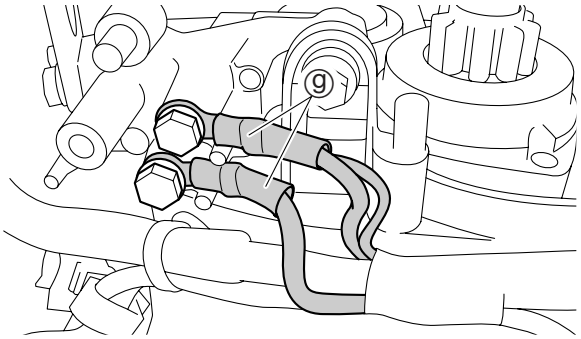
3. Remove the wiring harness from the clamp ②.



4. Remove the ground leads ⓕ.

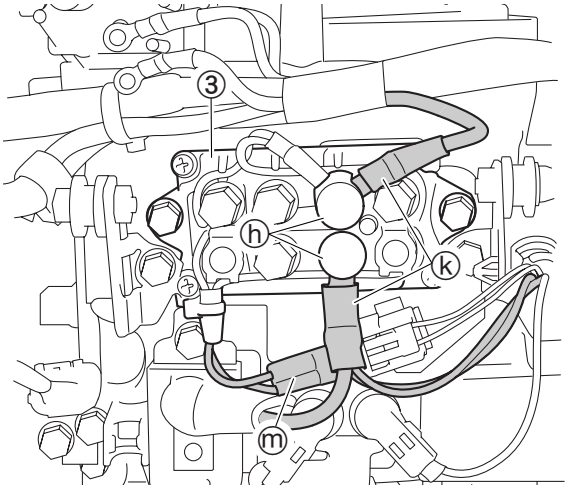


5. Remove the ground leads ⓖ.

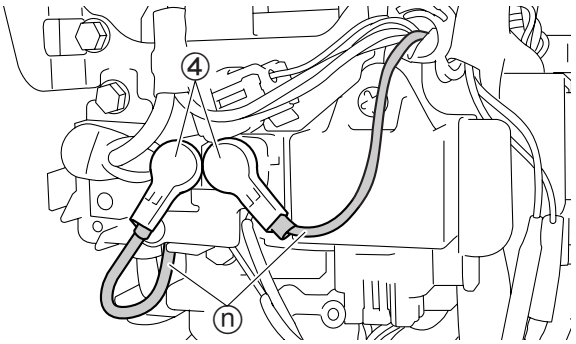


6. Remove the caps ⓗ, and then remove the PTT relay leads ⓚ (PTT model).

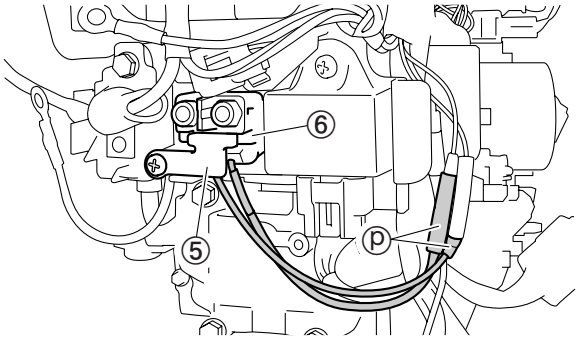
7. Disconnect the PTT relay coupler ⓜ, and then remove the PTT relay ③ (PTT model).



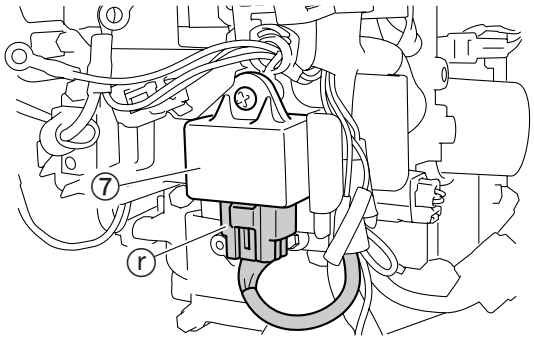
8. Remove the caps ④, and then remove the starter relay leads ⓝ.



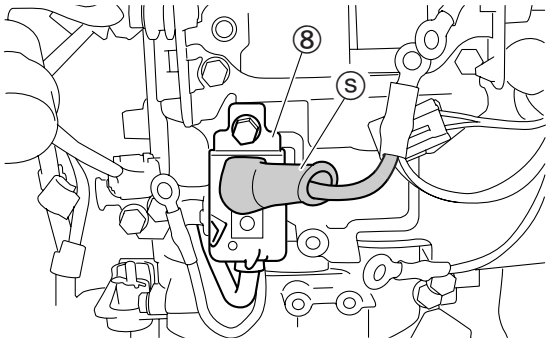
9. Disconnect the starter relay connectors ⓟ, and then remove the plate ⑤ and the starter relay ⑥.



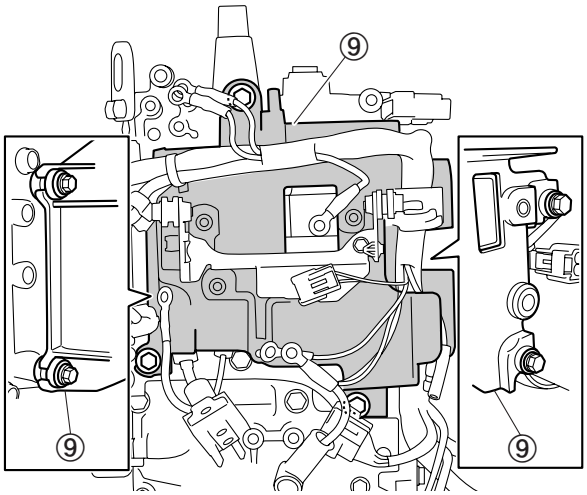
10. Disconnect the main relay coupler ⓡ, and then remove the main relay ⑦.



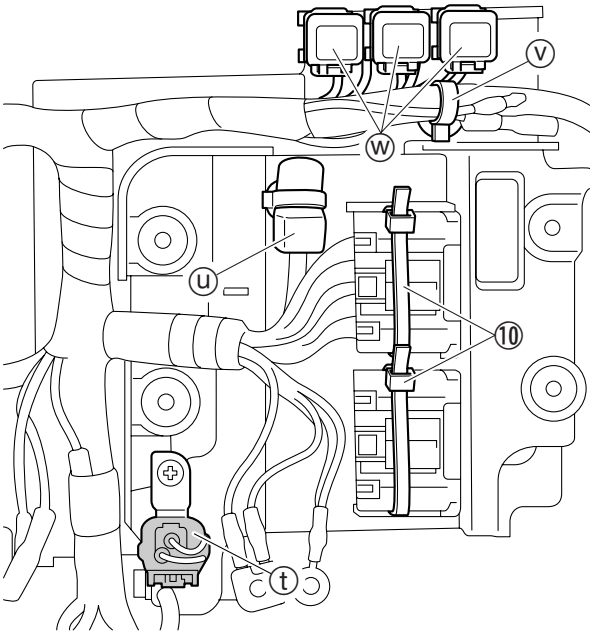
11. Remove the terminal lead ⓢ, and then remove the terminal ⑧.



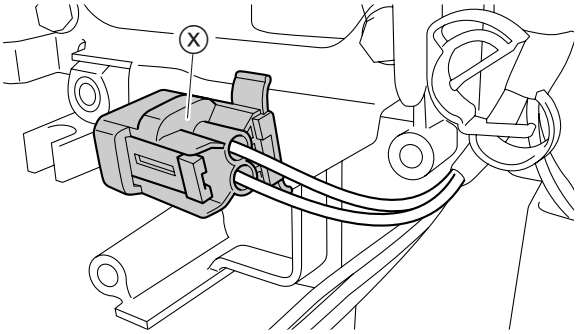
12. Remove the bracket ⑨.



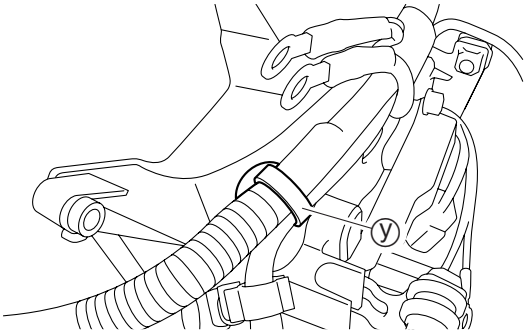
13. Remove the YDIS coupler ⓣ, and then disconnect the plastic ties ⑩, the diode ⓤ, the clamp ⓥ, and the fuse holders ⓦ.



14. Remove the PTT relay coupler ⓧ (PTT model).



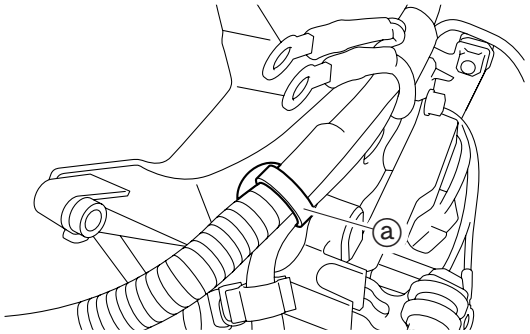
15. Remove the clamp ⓨ.



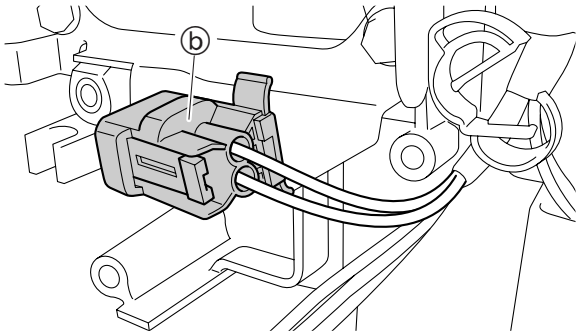
Installing the wiring harness

To install all the wiring harnesses, see “Electrical component and wiring harness routing” (5-1).

1. Install the clamp ⓐ.

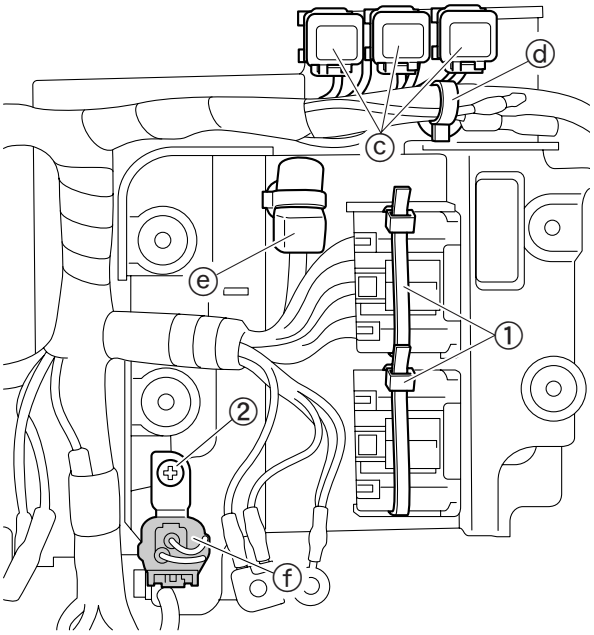


2. Install the PTT relay coupler ⓑ (PTT model).



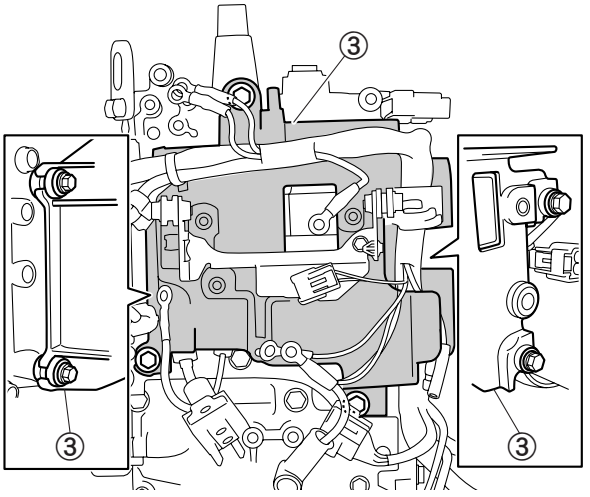
3. Connect the fuse holders ⓒ, the clamp ⓓ, the diode ⓔ, and the plastic ties ①, and then install the YDIS coupler ⓕ.

4. Tighten the YDIS coupler screw ② to the specified torque.



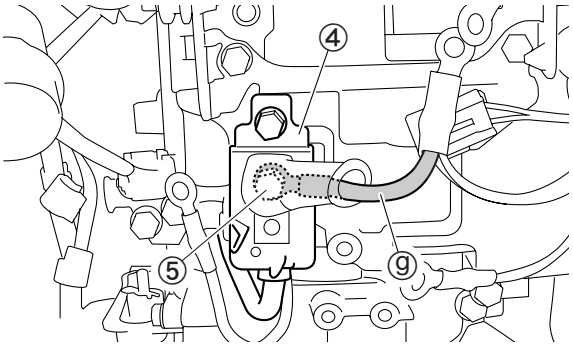
YDIS coupler screw ②:
3 N·m (0.3 kgf·m, 2.2 ft·lb)

5. Install the bracket ③.



6. Install the terminal ④, and then install the terminal lead ⓖ.

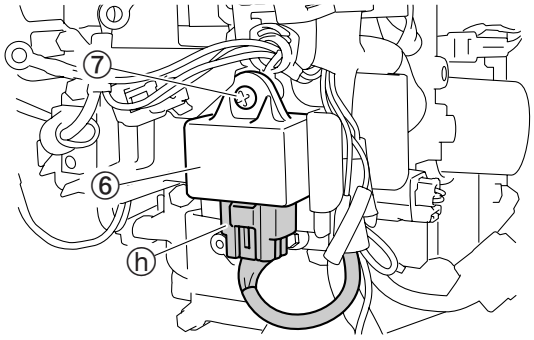
7. Tighten the terminal bolt ⑤ to the specified torque.



Terminal bolt ⑤: 4 N·m (0.4 kgf·m, 3.0 ft·lb)

8. Install the main relay ⑥, and then tighten the main relay screw ⑦ to the specified torque.

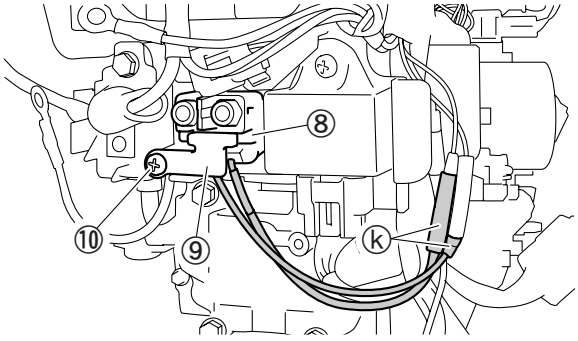
9. Connect the main relay coupler ⓗ.



Main relay screw ⑦: 3 N·m (0.3 kgf·m, 2.2 ft·lb)

10. Install the starter relay ⑧ and the plate ⑨, and then connect the starter relay connectors ⓚ.

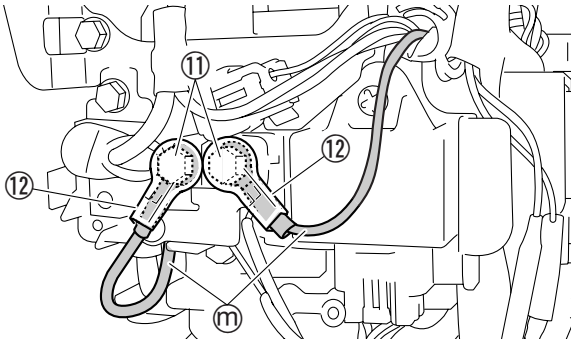
11. Tighten the starter relay screw ⑩ to the specified torque.



Starter relay screw ⑩: 3 N·m (0.3 kgf·m, 2.2 ft·lb)

12. Install the starter relay leads ⓜ, and then tighten the starter relay lead bolts ⑪ to the specified torque.

13. Install the caps ⑫.

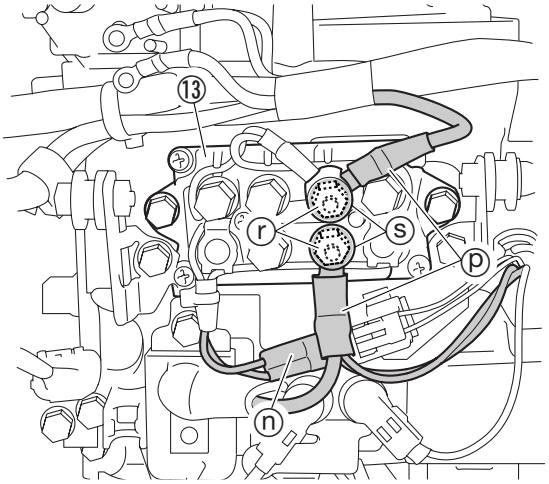


Starter relay lead bolt ⑪: 4 N·m (0.4 kgf·m, 3.0 ft·lb)

14. Install the PTT relay ⑬, and then connect the PTT relay coupler ⓝ (PTT model).

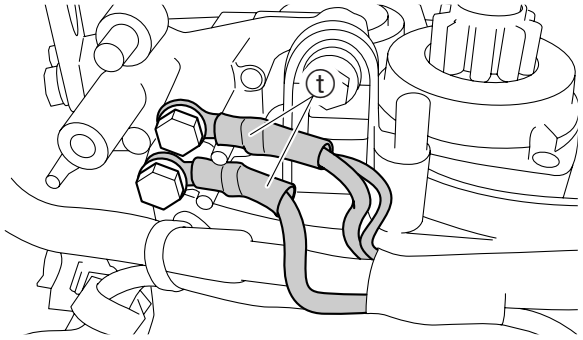
15. Install the PTT relay leads ⓟ, and then tighten the PTT relay lead nuts ⓡ to the specified torque (PTT model).

16. Install the caps ⓢ (PTT model).

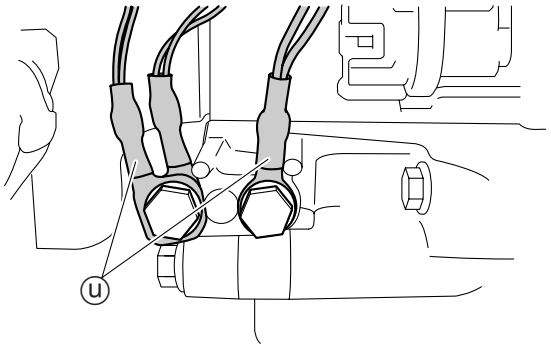


PTT relay lead nut ⓡ: 4 N·m (0.4 kgf·m, 3.0 ft·lb)

17. Install the ground leads ⓣ.

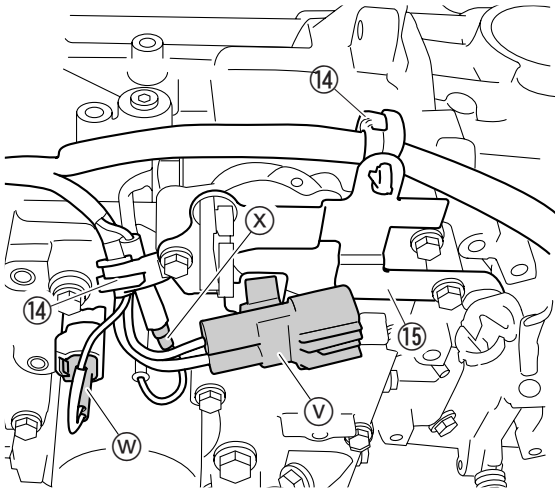


18. Remove the ground leads ⓤ.

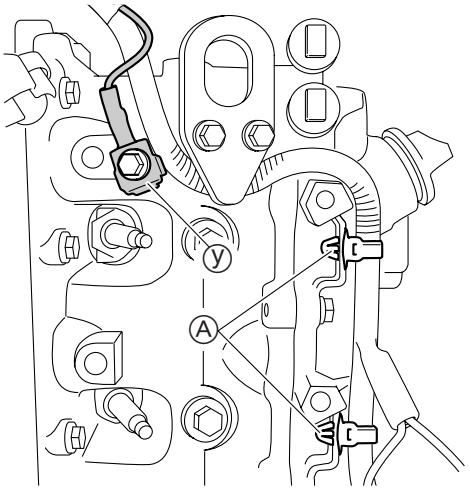


19. Install the wiring harness to the clamps ⑭.

20. Install the Rectifier Regulator coupler ⓥ to the bracket ⑮, and then connect the thermo sensor coupler ⓦ and the oil pressure switch connector ⓧ.

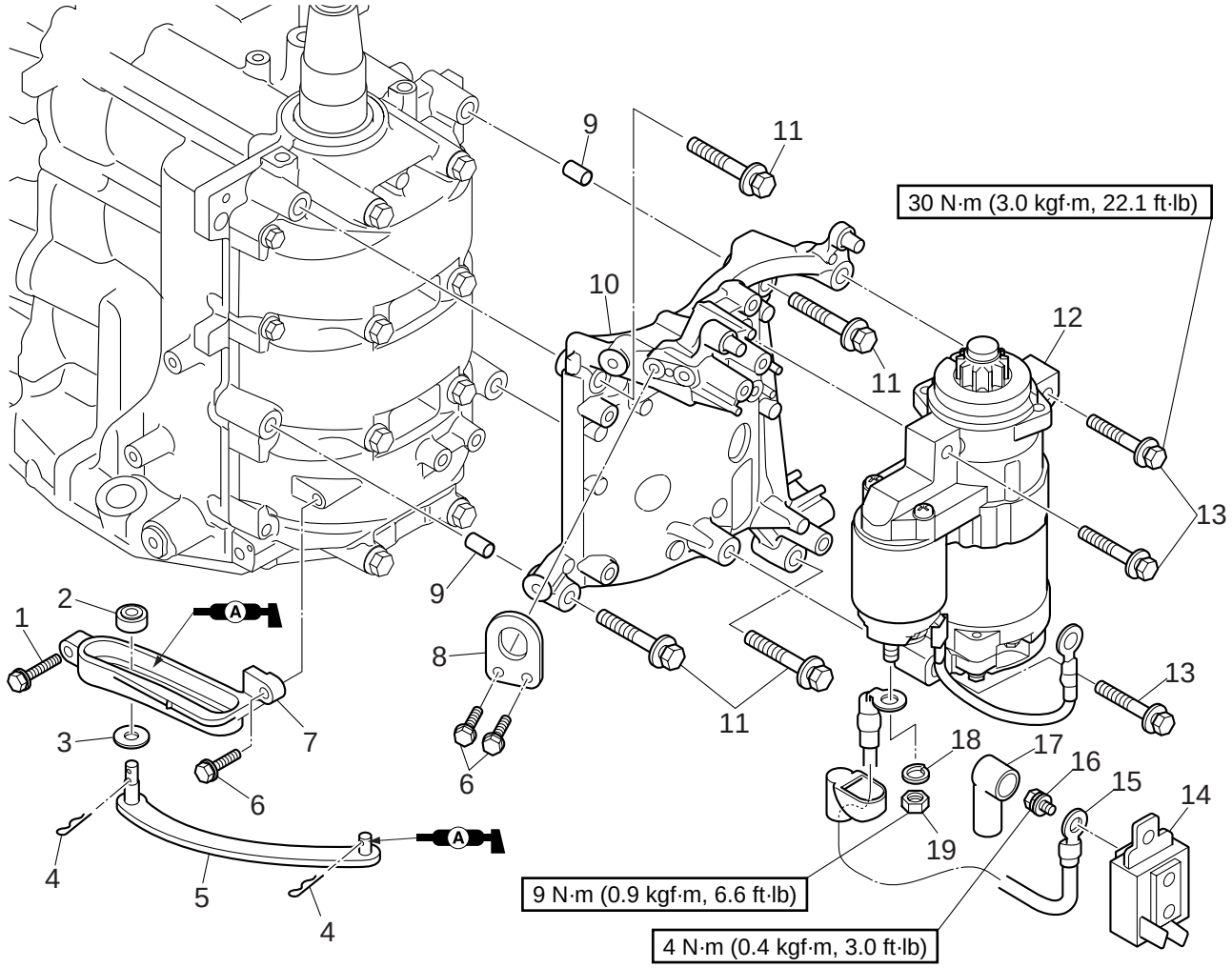


21. Install the ground lead ⓨ and the clamps Ⓐ.

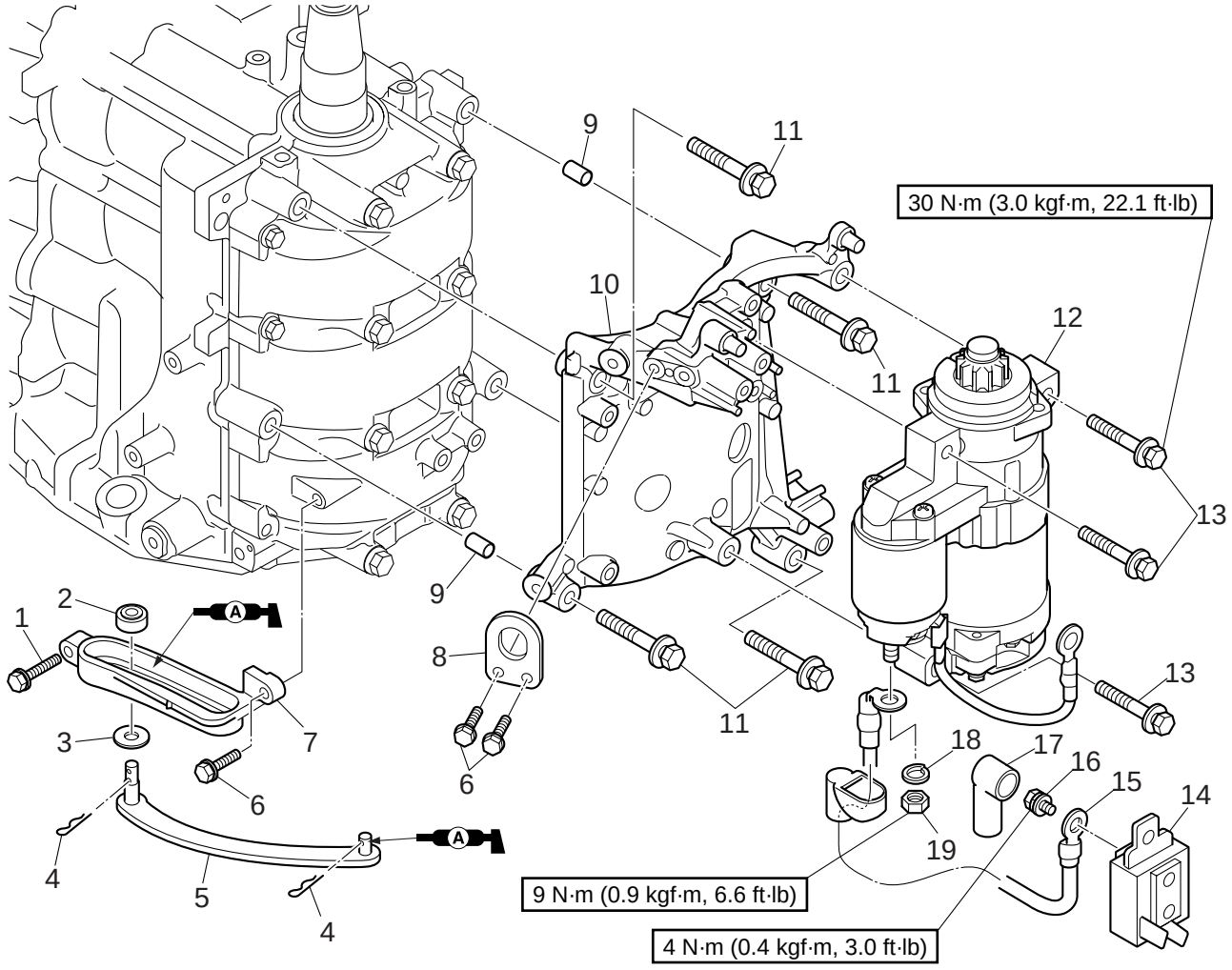


7

Starter motor



No.	Part name	Q'ty	Remarks
1	Bolt	1	M6 × 25 mm
2	Bushing	1	
3	Washer	1	
4	Clip	2	
5	Shift rod lever	1	
6	Bolt	3	M6 × 20 mm
7	Bracket	1	
8	Engine hanger	1	
9	Dowel	2	
10	Bracket	1	
11	Bolt	4	M8 × 45 mm
12	Starter motor	1	
13	Bolt	3	M8 × 45 mm
14	Terminal	1	
15	Starter motor lead	1	
16	Bolt	1	M6 × 10 mm
17	Cap	1	



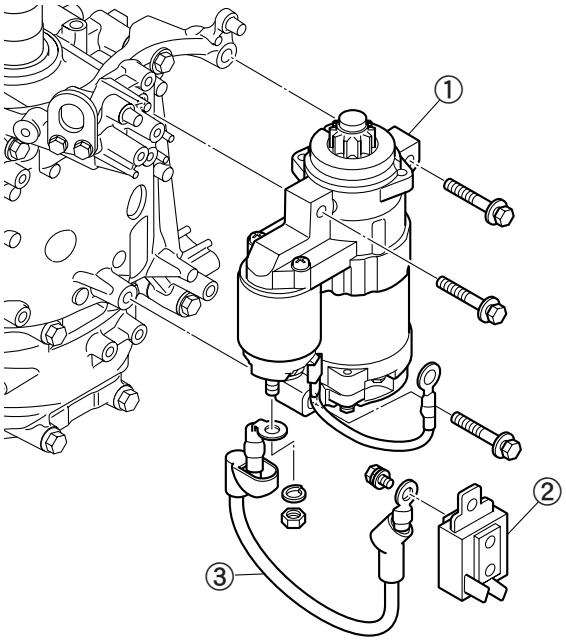
No.	Part name	Q'ty	Remarks
18	Spring washer	1	
19	Nut	1	

7

Removing the starter motor

1. Remove the starter motor ①.

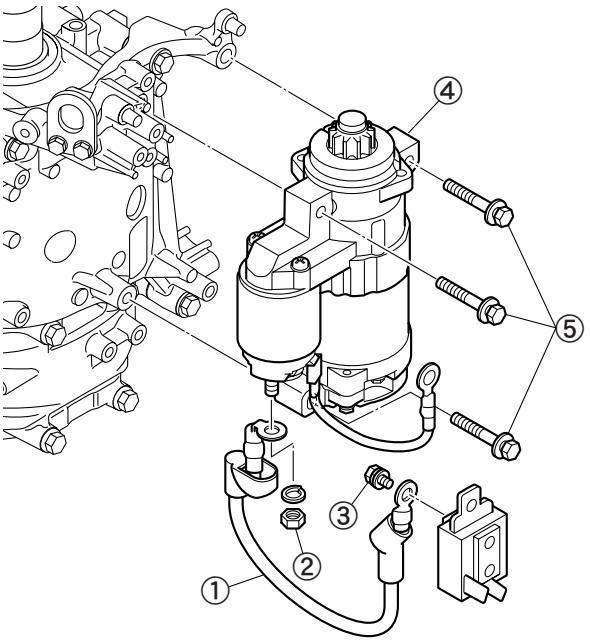
2. Remove the terminal ② and the starter motor lead ③.



Installing the starter motor

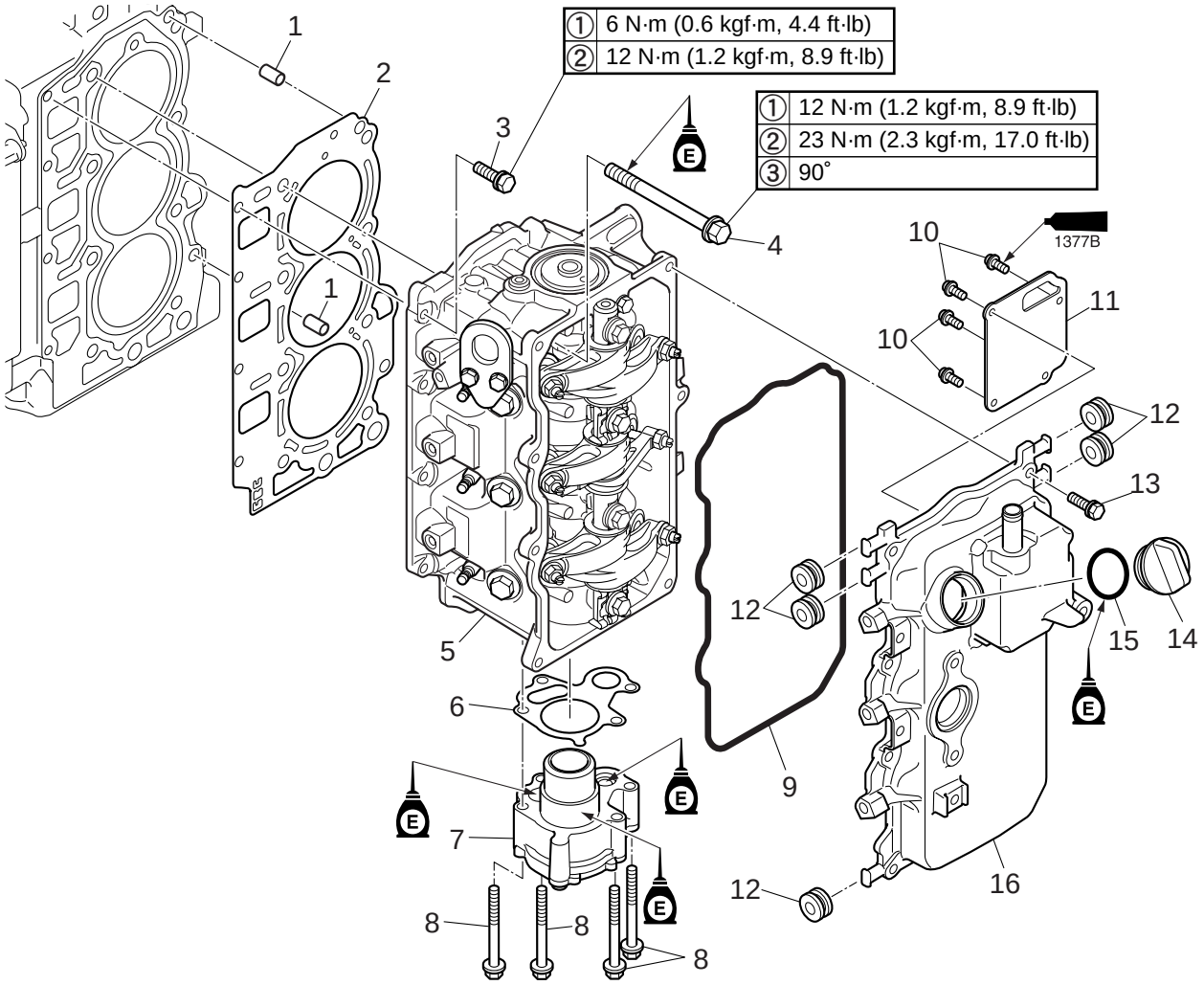
1. Install the starter motor lead ①, and then tighten the starter motor lead nut ② and the starter motor lead bolt ③ to the specified torque.

2. Install the starter motor ④, and then tighten the starter motor bolt ⑤ to the specified torque.



Starter motor lead nut ②:
9 N·m (0.9 kgf·m, 6.6 ft·lb)
Starter motor lead bolt ③:
4 N·m (0.4 kgf·m, 3.0 ft·lb)
Starter motor bolt ⑤:
30 N·m (3.0 kgf·m, 22.1 ft·lb)

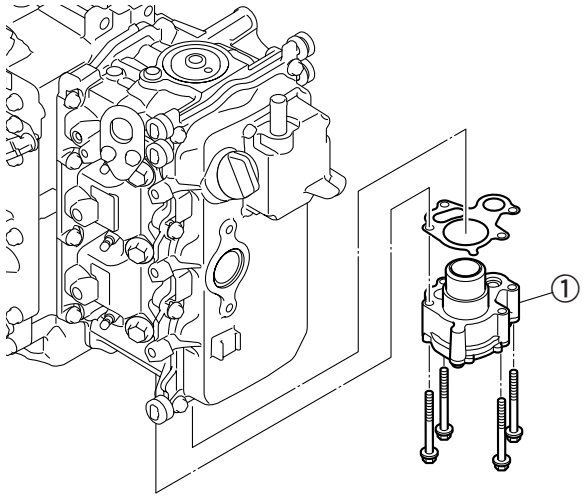
Cylinder head



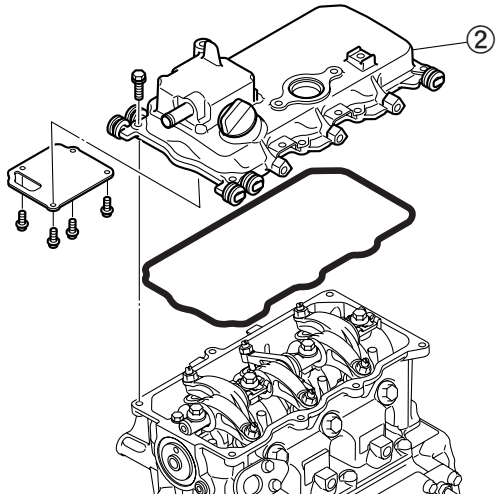
No.	Part name	Q'ty	Remarks
1	Dowel	2	
2	Gasket	1	**Not reusable**
3	Bolt	4	M6 × 25 mm
4	Bolt	8	M9 × 93 mm
5	Cylinder head assembly	1	
6	Gasket	1	**Not reusable**
7	Oil pump assembly	1	
8	Bolt	4	M6 × 45 mm
9	Gasket	1	**Not reusable**
10	Screw	4	M4 × 10 mm
11	Plate	1	
12	Grommet	5	
13	Bolt	7	M6 × 20 mm
14	Oil filler cap	1	
15	O-ring	1	
16	Cylinder head cover	1	

Removing the cylinder head

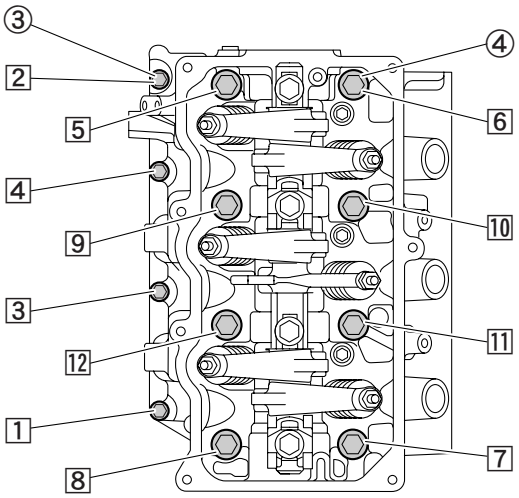
1. Remove the oil pump assembly ①.



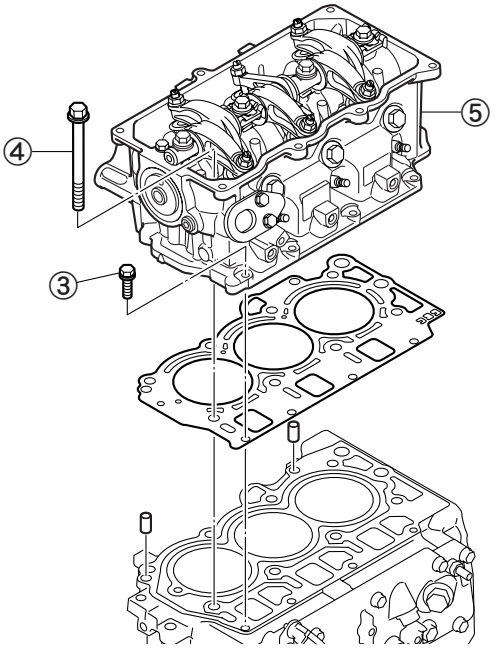
2. Remove the cylinder head cover ②.



3. Loosen the cylinder head bolts ③ and ④ in the sequence numbers (1, 2, · · ·).

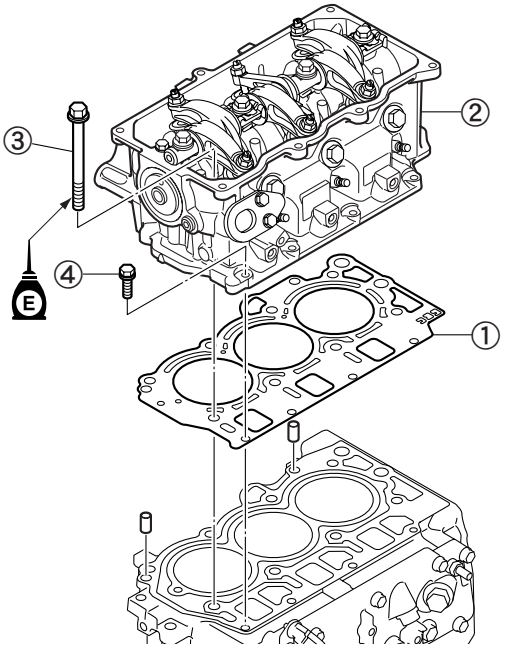


4. Remove the cylinder head bolts ③ and ④, and then remove the cylinder head ⑤. ***NOTICE:*** **Do not scratch or damage the mating surfaces of the cylinder head and cylinder block**.

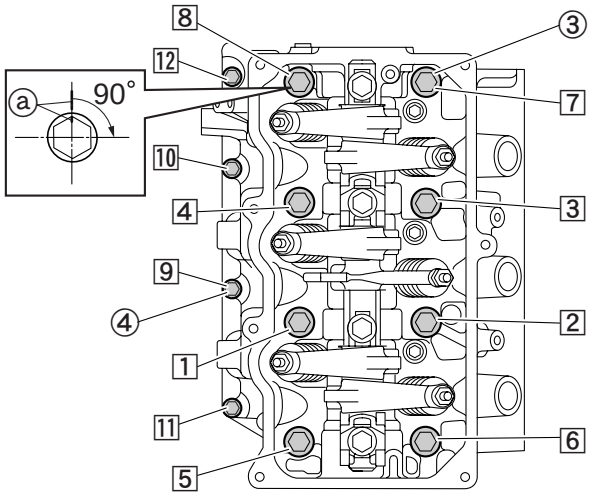


Installing the cylinder head

1. Install a new gasket ①, the cylinder head ②, and the cylinder head bolts ③ and ④.



2. Tighten the cylinder head bolts ③ and ④ to the specified torque in the sequence numbers (1, 2, · · ·). ***NOTICE:*** **Do not reuse the cylinder head gasket. Always replace it with a new one**.

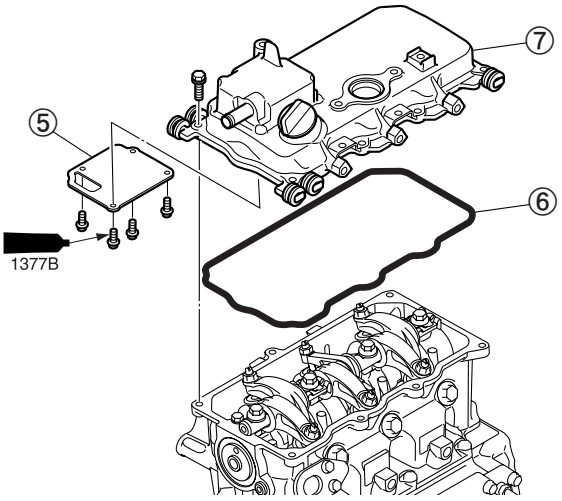


Cylinder head bolt ③ 1–8 (M9):
1st: 12 N·m (1.2 kgf·m, 8.9 ft·lb)
2nd: 23 N·m (2.3 kgf·m, 17.0 ft·lb)
3rd: 90°
Cylinder head bolt ④ 9–12 (M6):
1st: 6 N·m (0.6 kgf·m, 4.4 ft·lb)
2nd: 12 N·m (1.2 kgf·m, 8.9 ft·lb)

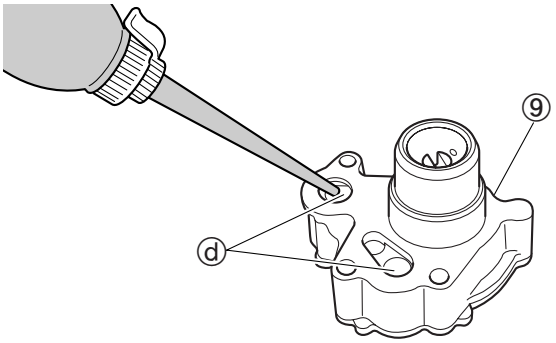
TIP:

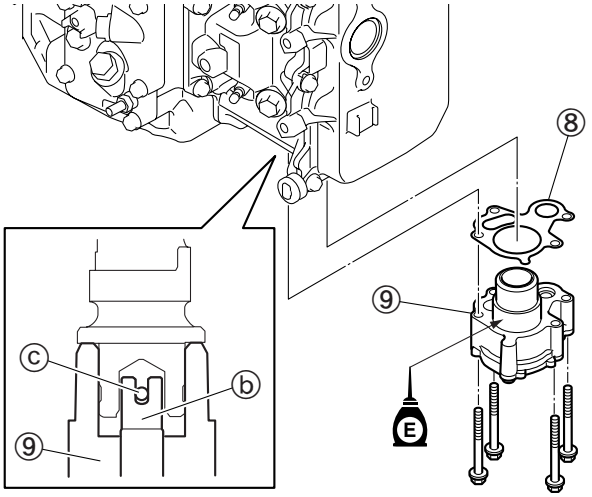
- Tighten the M9 bolts ③ 1–8 to the specified torque in 3 stages. In the 3rd stage, make a mark ⓐ on the M9 bolts and the cylinder head, and then tighten the M9 bolts 90° from the mark.
- After tightening the M9 bolts ③ 1–8 has been completed, tighten the M6 bolts ④ 9–12 to the specified torque in 2 stages.

3. Install the plate ⑤, a new gasket ⑥, and the cylinder head cover ⑦.



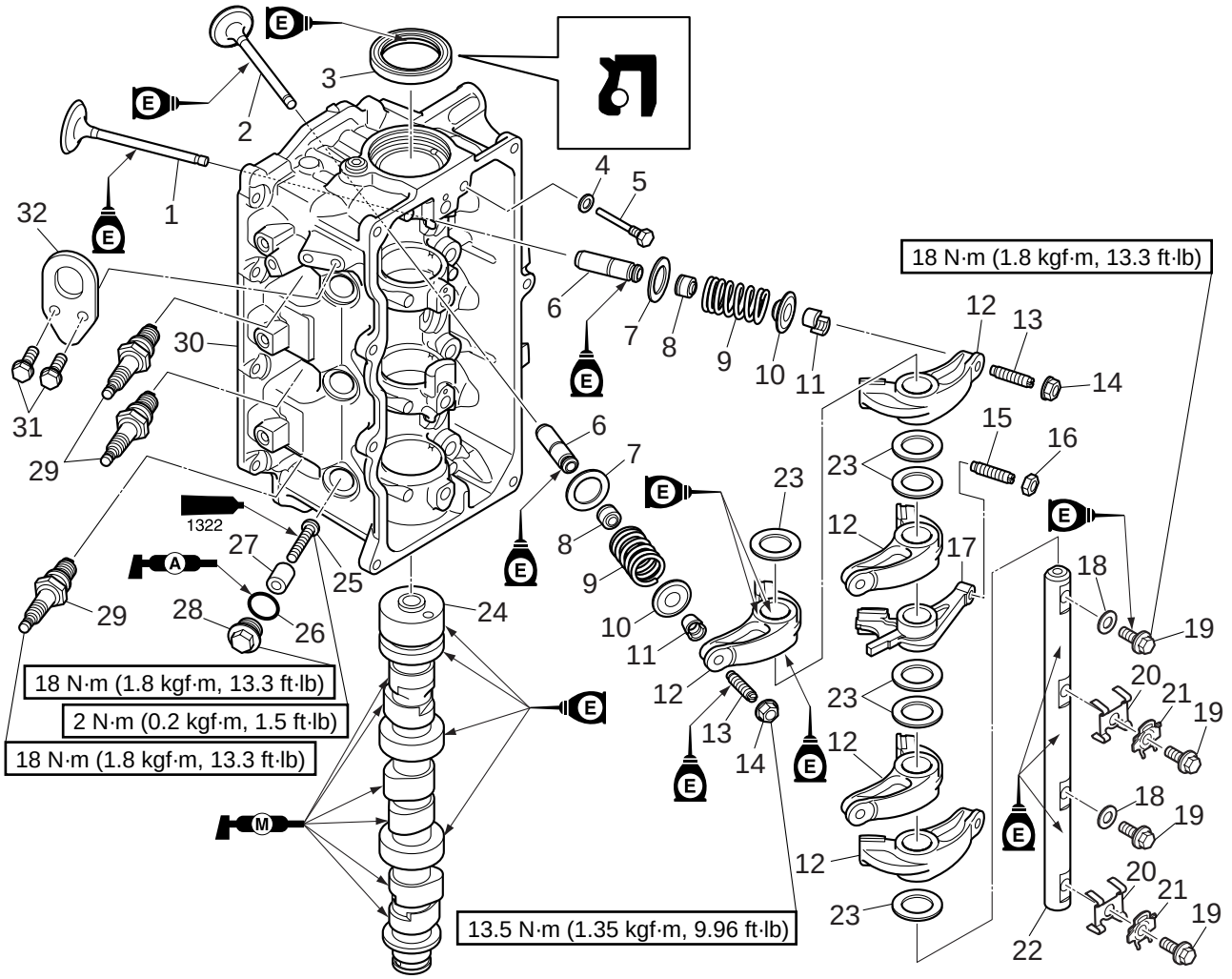
4. Install a new gasket ⑧ and the oil pump assembly ⑨ aligning the slot in the oil pump drive shaft ⓑ with the camshaft pin ⓒ. ***NOTICE:*** **Before installing the oil pump assembly ⑨, make sure to fill it with engine oil through the oil passage** ⓓ.



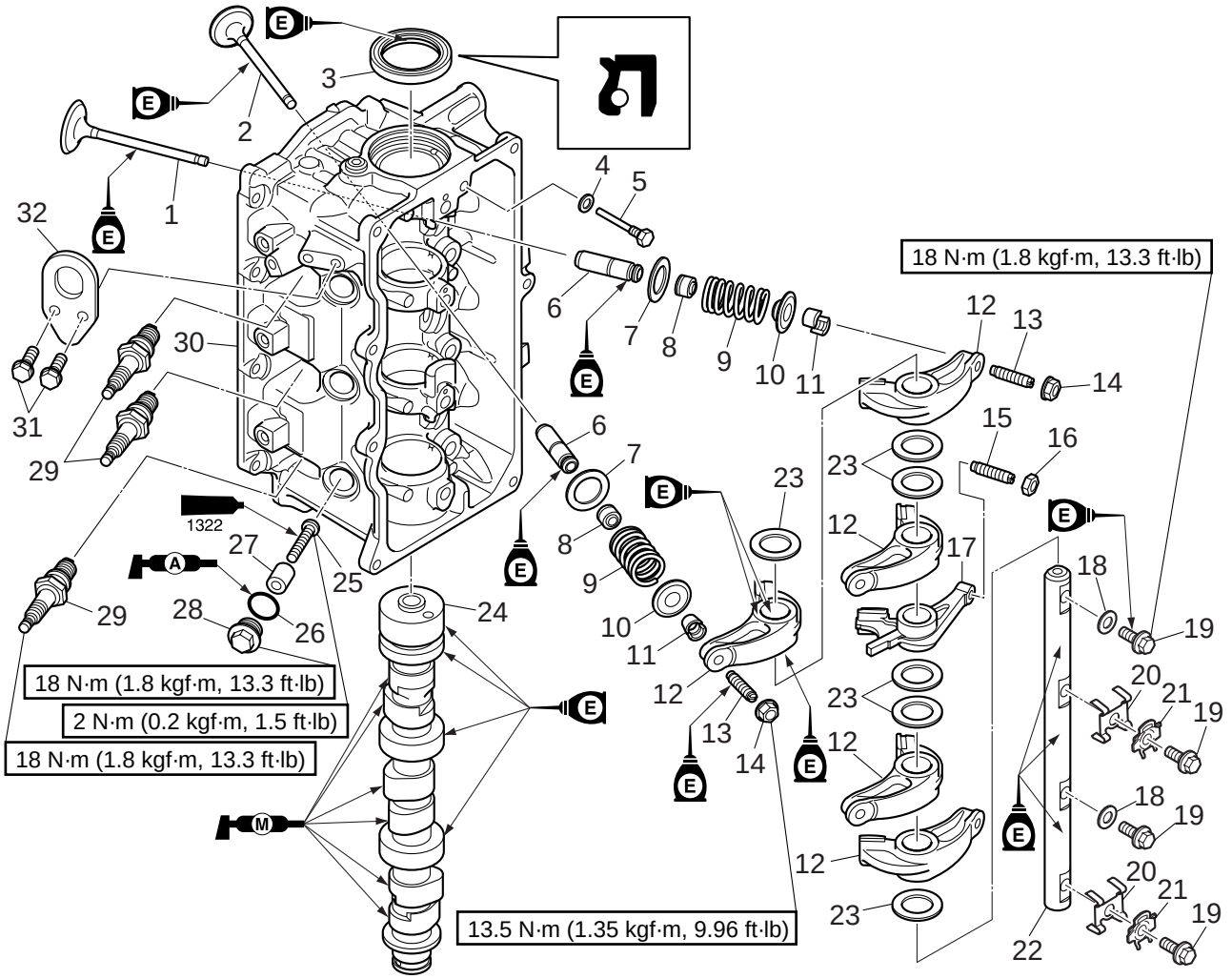


7

Camshaft and valve



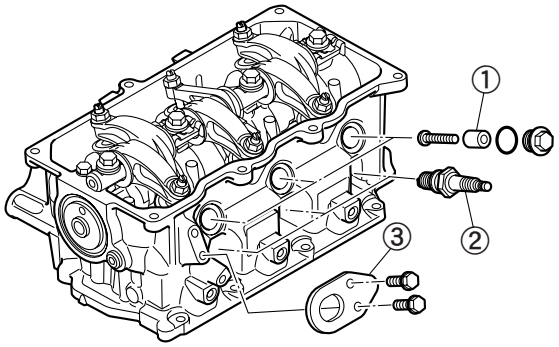
No.	Part name	Q'ty	Remarks
1	Intake valve	3	
2	Exhaust valve	3	
3	Oil seal	1	**Not reusable**
4	Gasket	1	**Not reusable**
5	Retaining bolt	1	
6	Valve guide	6	**Not reusable**
7	Valve spring seat	6	
8	Valve seal	6	**Not reusable**
9	Valve spring	6	
10	Valve spring retainer	6	
11	Valve cotter	12	
12	Rocker arm	5	
13	Adjusting screw	5	
14	Nut	5	
15	Adjusting screw	1	
16	Nut	1	
17	Rocker arm	1	



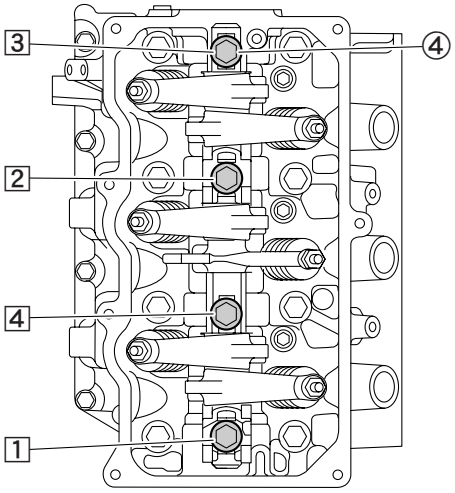
No.	Part name	Q'ty	Remarks
18	Washer	2	
19	Bolt	4	M8 × 22 mm
20	Tensioner	2	
21	Stopper	2	
22	Rocker arm shaft	1	
23	Washer	6	
24	Camshaft	1	
25	Screw	3	M5 × 24 mm
26	O-ring	3	**Not reusable**
27	Anode	3	
28	Anode plug	3	
29	Spark plug	3	
30	Cylinder head	1	
31	Bolt	2	M6 × 20 mm
32	Engine hanger	1	

Disassembling the cylinder head

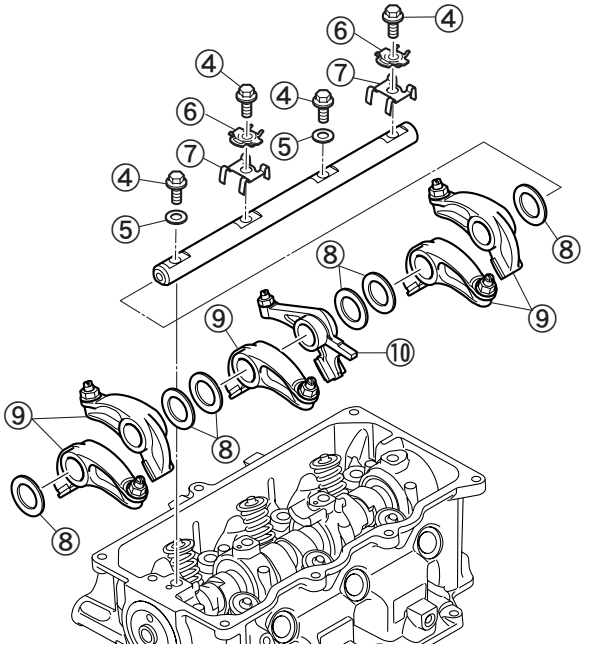
1. Remove the cylinder head anodes ①, the spark plugs ②, and the engine hanger ③.



2. Gradually loosen the rocker arm shaft bolts ④ in several stages and in the sequence numbers (1, 2, · · ·).



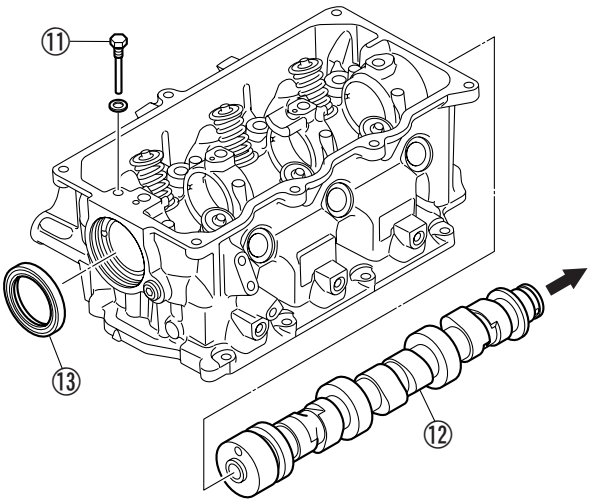
3. Remove the rocker arm shaft bolts ④, the washers ⑤, the stoppers ⑥, and the tensioners ⑦, and then remove the washers ⑧, and the rocker arms ⑨ and ⑩.



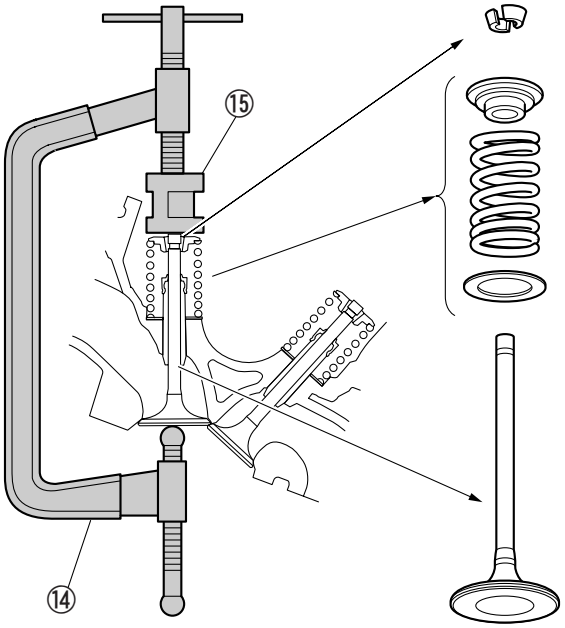
TIP:

Make sure to keep the parts in their original groups.

4. Remove the retaining bolt ⑪, and then remove the camshaft ⑫ and the oil seal ⑬.



5. Remove the intake and exhaust valves.



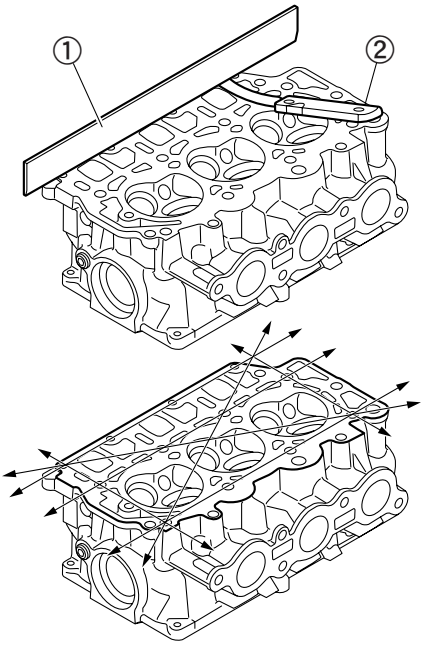
Valve spring compressor ⑭: 90890-04019
Valve spring compressor attachment ⑮: 90890-06320

TIP:
Make sure to keep the parts in their original groups.

Checking the cylinder head

1. Eliminate any carbon deposits from the combustion chambers and check for deterioration.

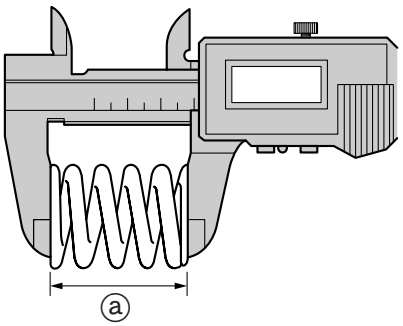
2. Check the cylinder head warpage using a straightedge ① and a thickness gauge ② in 7 directions. Replace the cylinder head assembly if above specification.



Cylinder head warpage limit:
0.10 mm (0.0039 in)

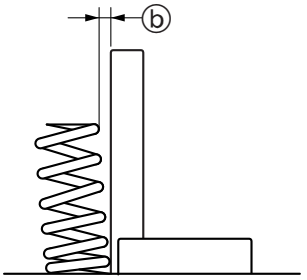
Checking the valve spring

1. Measure the valve spring free length ⓐ. Replace if below specification.



Valve spring free length ⓐ:
39.85 mm (1.57 in)

2. Measure the valve spring tilt ⓑ. Replace if above specification.



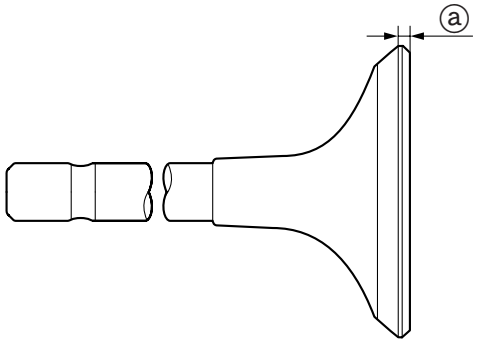
7

Valve spring tilt ⓑ: 1.7 mm (0.07 in)

Checking the valve

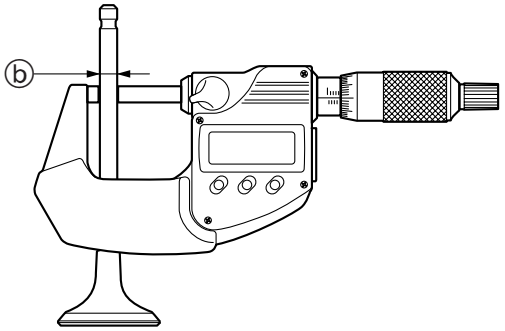
1. Check the valve face. Replace if pitted or worn.

2. Measure the valve margin thickness ⓐ. Replace if out of specification.



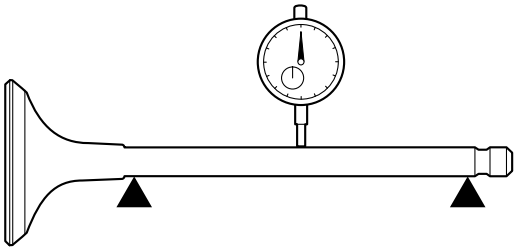
Valve margin thickness ⓐ:
Intake:
0.80–1.20 mm (0.0315–0.0472 in)
Exhaust:
1.00–1.40 mm (0.0394–0.0551 in)

3. Measure the valve stem diameter ⓑ. Replace if out of specification.



Valve stem diameter ⓑ:
Intake:
5.475–5.490 mm (0.2156–0.2161 in)
Exhaust:
5.460–5.475 mm (0.2150–0.2156 in)

4. Measure the valve stem runout. Replace if above specification.

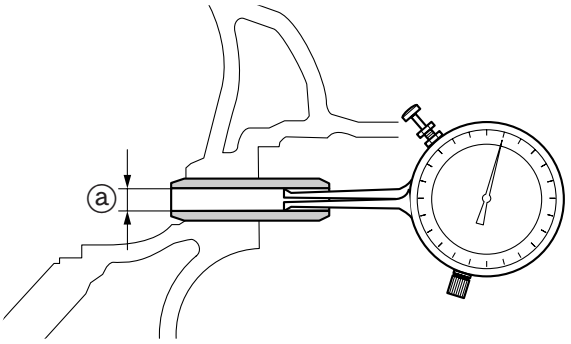


Valve stem runout: 0.01 mm (0.0004 in)

Checking the valve guide

Before checking the valve guides, make sure that the valve stem diameter is within specification.

1. Measure the valve guide inside diameter ⓐ. Replace if out of specification.



Valve guide inside diameter ⓐ:
5.500–5.512 mm (0.2165–0.2170 in)

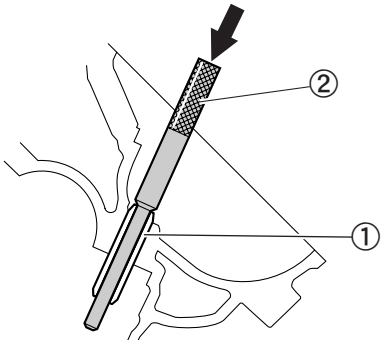
2. Calculate the valve stem-to-valve guide clearance as follows. Replace the valve guide if out of specification.

Valve stem-to-valve guide clearance = valve guide inside diameter – valve stem diameter:
Intake:
0.010–0.037 mm (0.0004–0.0015 in)
Exhaust:
0.025–0.052 mm (0.0010–0.0020 in)

Replacing the valve guide

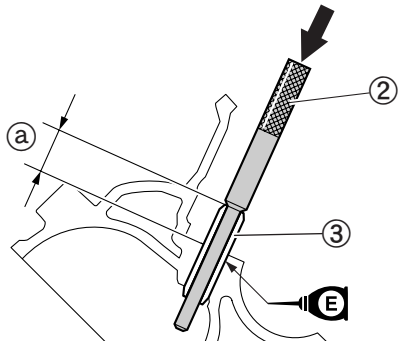
After replacing a valve guide, check the valve seat contact area.

1. Remove the valve guide ① from the combustion chamber side using the special service tool ②.



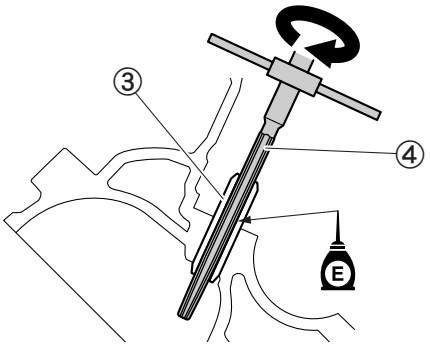
Valve guide remover/installer ②:
90890-06801

2. Install a new valve guide ③ from the camshaft side to the specified position ⓐ using the special service tool ②.



Valve guide position ⓐ:
16.3–16.7 mm (0.64–0.66 in)

3. Insert the special service tool ④ into the valve guide ③, and then ream the valve guide.



Valve guide reamer ④: 90890-06804

TIP:

- Turn the valve guide reamer clockwise to ream the valve guide.
- Do not turn the reamer counterclockwise when removing it.
- Make sure to clean the valve guide after reaming it.

4. Measure the valve guide inside diameter.

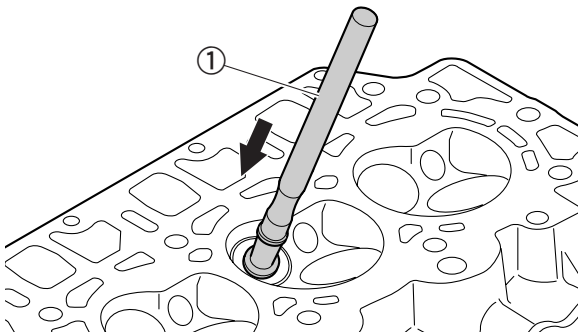
Valve guide inside diameter:
5.500–5.512 mm (0.2165–0.2170 in)

Checking the valve seat

1. Eliminate any carbon deposits from the valves.

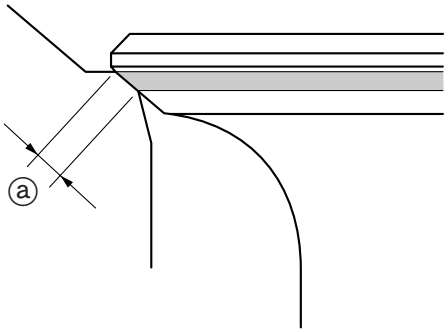
2. Apply a thin, even layer of Mechanic's blueing dye (Dykem) onto the valve seats.

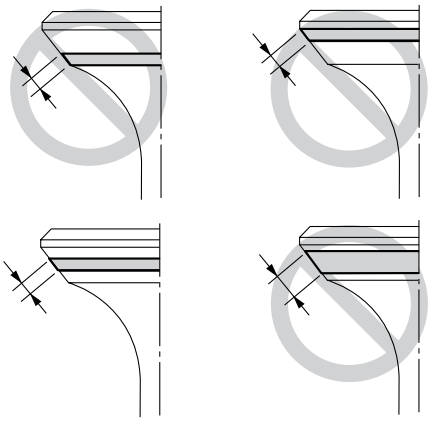
3. Lap the valve slowly on the valve seat with the special service tool ①.



Valve lapper ①: 90890-04101

4. Measure the valve seat contact width ⓐ where the blueing dye is adhered to the valve face. Reface the valve seat if the valve is not seated properly or if the valve seat contact width is out of specification. Replace the valve guide if the valve seat contact width is uneven.





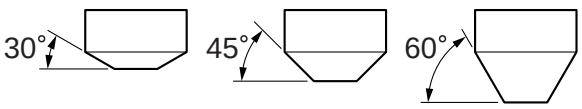
Valve seat contact width ⓐ:
1.30–1.50 mm (0.051–0.059 in)

Refacing the valve seat

NOTICE

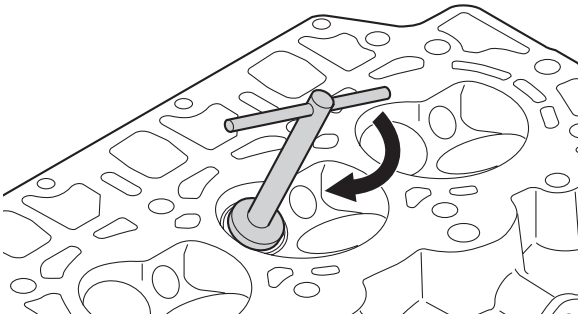
After every lapping procedure, make sure to clean off any remaining lapping compound from the cylinder head and the valves.

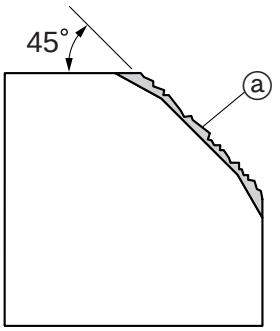
1. Reface the valve seats with the valve seat cutters.



Valve seat cutter holder: 90890-06316
Intake:
Valve seat cutter 30°: 90890-06326
Valve seat cutter 45°: 90890-06312
Valve seat cutter 60°: 90890-06323
Exhaust:
Valve seat cutter 30°: 90890-06328
Valve seat cutter 45°: 90890-06325
Valve seat cutter 60°: 90890-06315

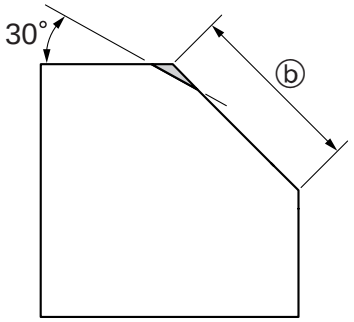
2. Cut the surface of the valve seat with a 45° cutter by turning the cutter clockwise until the valve seat face has become smooth. ***NOTICE:*** **Do not overcut the valve seat. Make sure to turn the cutter evenly downward at a pressure of 40–50 N (4.0–5.0 kgf, 8.8–11.0 lbf) to prevent chatter marks.**





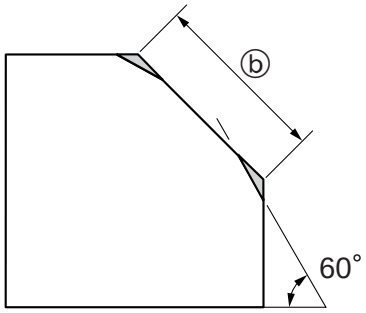
ⓐ Slag or rough surface

3. Use a 30° cutter to adjust the contact width of the valve seat top edge.



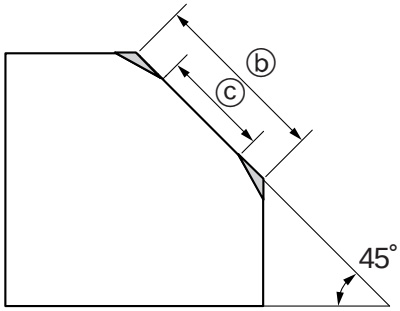
ⓑ Previous contact width

4. Use a 60° cutter to adjust the contact width of the valve seat bottom edge.



ⓑ Previous contact width

5. Use a 45° cutter to adjust the contact width of the valve seat to specification.

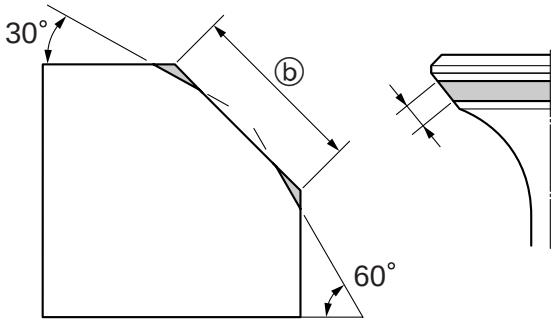


ⓑ Previous contact width
ⓒ Specified contact width

6. Check the valve seat contact area of the valve. See “Checking the valve seat” (7-38).

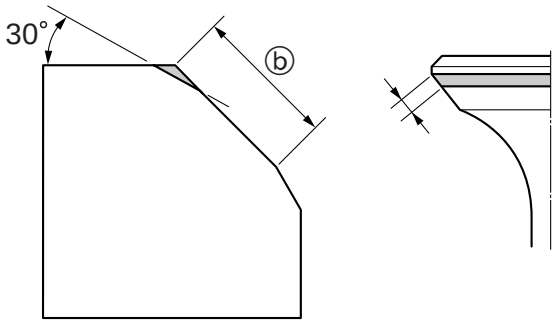
Example:

- If the valve seat contact area is too wide and situated in the center of the valve face, use a 30° cutter to cut the valve seat top edge, and then use a 60° cutter to cut the bottom edge to center the area and set its width.



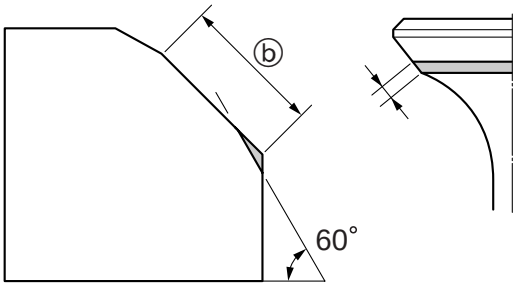
ⓑ Previous contact width

- If the valve seat contact area is too narrow and situated near the top edge of the valve face, use a 30° cutter to cut the valve seat top edge, and then use a 45° cutter to center the area and set its width.



ⓑ Previous contact width

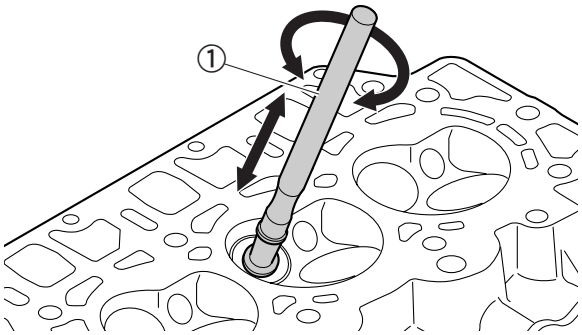
- If the valve seat contact area is too narrow and situated near the bottom edge of the valve face, use a 60° cutter to cut the valve seat bottom edge, and then use a 45° cutter to center the area and set its width.



ⓑ Previous contact width

7

7. After refacing the valve seat to the specified contact width, apply a thin, even layer of lapping compound onto the valve seat, and then lap the valve using the special service tool ①. ***NOTICE:*** **Do not get the lapping compound on the valve stem and valve guide.**



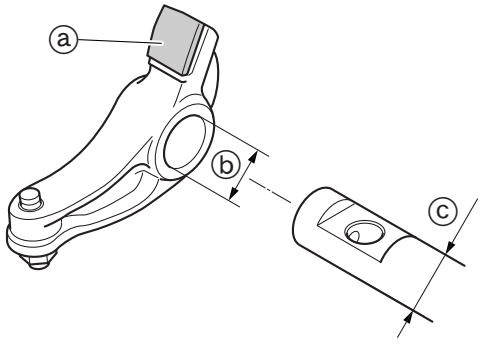
Valve lapper ①: 90890-04101

8. Check the valve seat contact area again. See “Checking the valve seat” (7-38).

Checking the rocker arm and rocker arm shaft

1. Check the rocker arms, the rocker arm shaft, and the contact surface ⓐ of each rocker arm. Replace if worn.

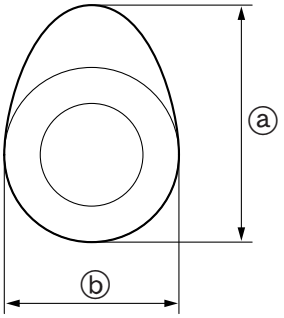
2. Measure the rocker arm inside diameter ⓑ and the rocker arm shaft outside diameter ⓒ. Replace if out of specification.



Rocker arm inside diameter ⓑ:
16.000–16.018 mm
(0.6299–0.6306 in)
Rocker arm shaft outside diameter ⓒ:
15.971–15.991 mm
(0.6288–0.6296 in)

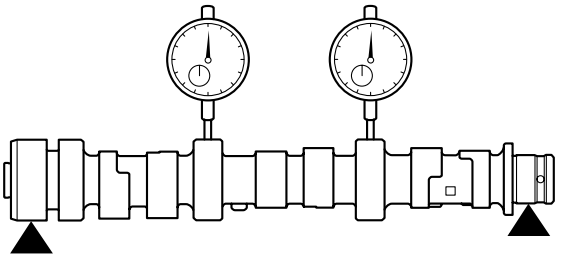
Checking the camshaft

1. Measure the cam lobe height ⓐ and width ⓑ. Replace if out of specification.



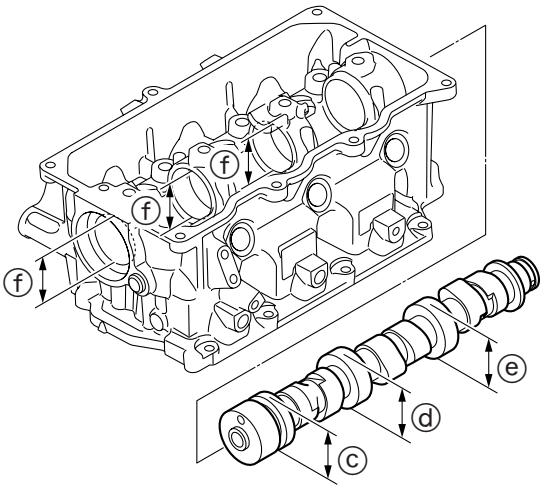
Cam lobe height ⓐ:
Intake:
30.737–30.837 mm
(1.2101–1.2141 in)
Exhaust:
30.933–31.033 mm
(1.2178–1.2218 in)
Cam lobe width ⓑ:
25.950–26.050 mm
(1.0217–1.0256 in)

2. Measure the camshaft runout. Replace if above specification.



Camshaft runout: 0.007 mm (0.0003 in)

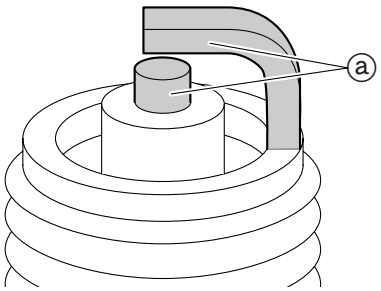
3. Measure the camshaft journal diameters ⓒ, ⓓ and ⓔ, and the cylinder head journal inside diameter ⓕ. Replace the camshaft or cylinder head assembly, or both if out of specifications.



Camshaft journal diameter #1 ⓒ:
36.925–36.945 mm
(1.4537–1.4545 in)
Camshaft journal diameter #2 ⓓ, #3 ⓔ:
36.935–36.955 mm
(1.4541–1.4549 in)
Cylinder head journal inside diameter ⓕ:
37.000–37.025 mm
(1.4567–1.4577 in)

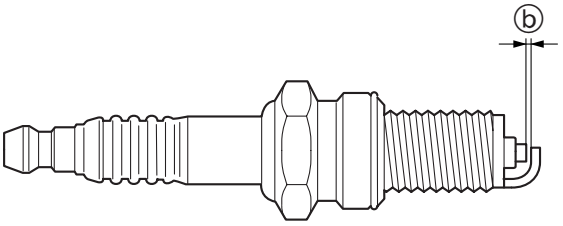
Checking the spark plug

1. Clean the electrodes ⓐ with a spark plug cleaner.



2. Check the spark plug. Replace if the electrodes are eroded, there is excessive carbon or other deposits.

3. Check the spark plug gap ⓑ. Replace if out of specification.



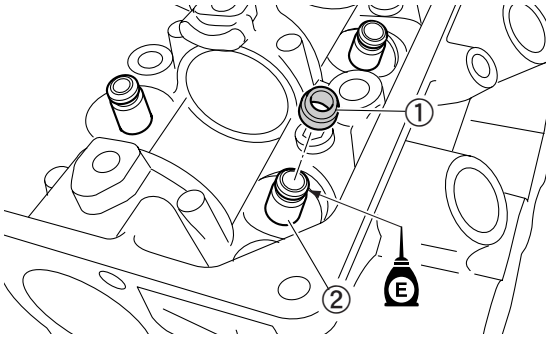
Specified spark plug: DPR6EB-9 (NGK)
Spark plug gap ⓑ:
0.8–0.9 mm (0.032–0.035 in)

Checking the cylinder head anode

1. Check the anodes. Clean if there is grease, oil, or scales. ***NOTICE:*** **Do not grease, oil, or paint the anodes.**

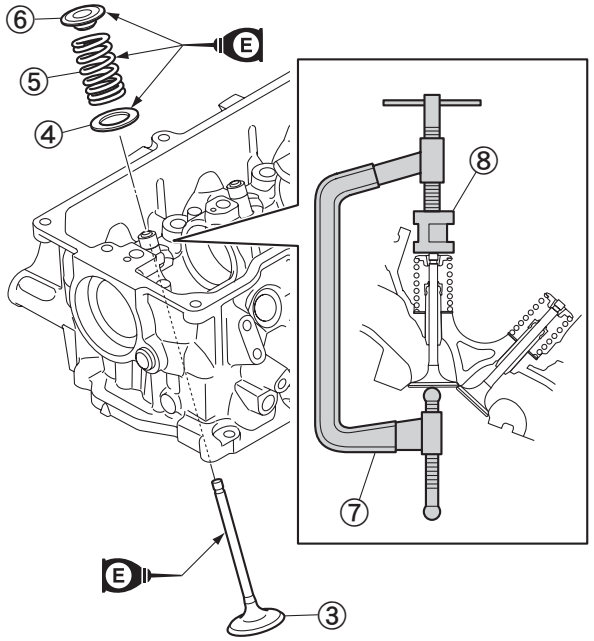
Assembling the cylinder head

1. Install a new valve seal ① onto the valve guide ②.



2. Install the valve ③, the valve spring seat ④, the valve spring ⑤, and the valve spring retainer ⑥ in this order, and then attach the special service tools ⑦ and ⑧.

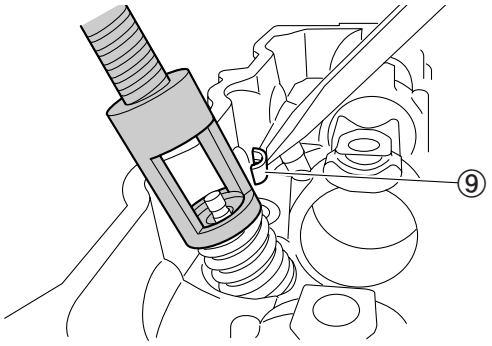
7



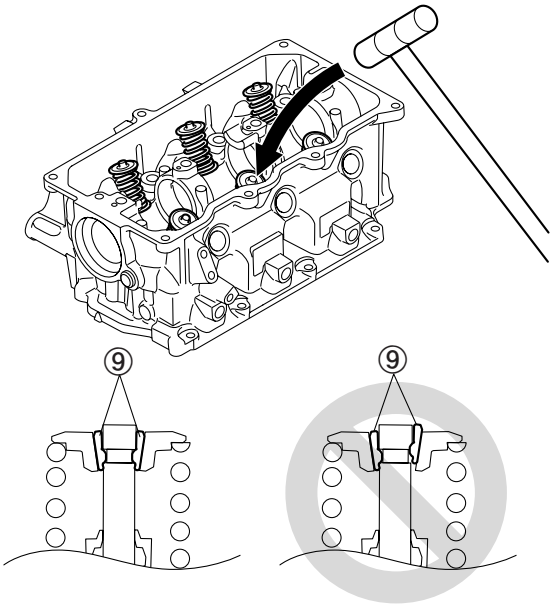
Valve spring compressor ⑦: 90890-04019
Valve spring compressor attachment ⑧: 90890-06320

TIP:
Face the fine pitch side of the valve spring toward the spring seat.

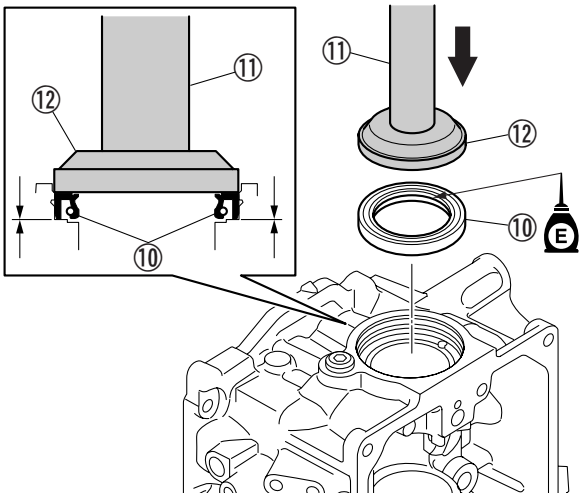
3. Compress the valve spring, and then install the valve cotters ⑨.



4. Lightly tap the valve spring retainer with a plastic hammer to set the valve cotters ⑨ securely.

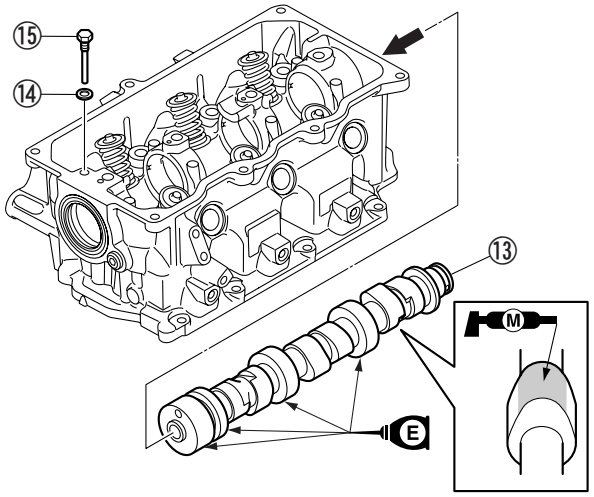


5. Install a new oil seal ⑩.

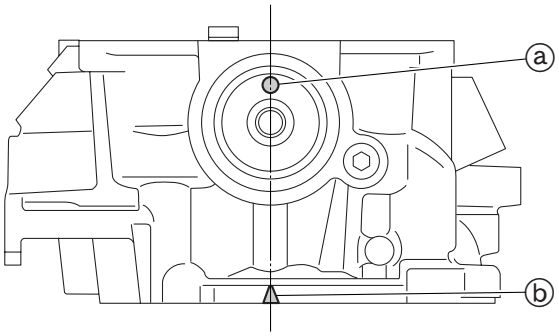


Driver rod LS ⑪: 90890-06606
Bearing outer race attachment ⑫: 90890-06626

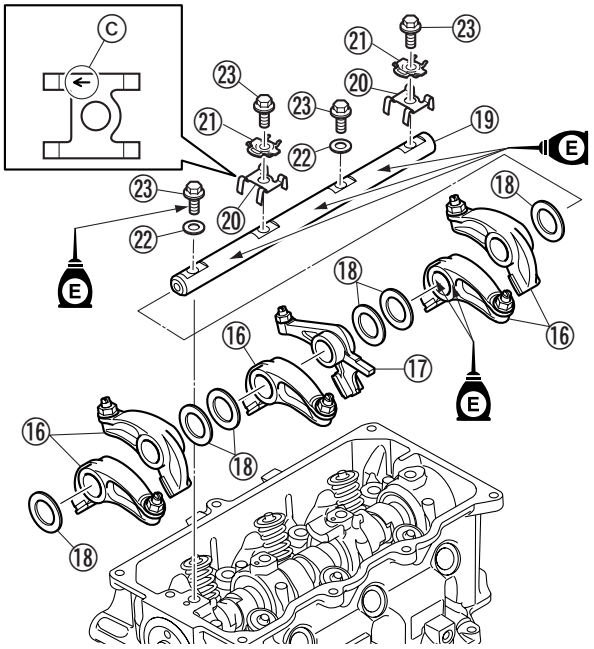
6. Install the camshaft ⑬ in the direction of the arrow, and then install a new gasket ⑭ and tighten the retaining bolt ⑮.



7. Align the dowel hole ⓐ in the camshaft with the "▲" mark ⓑ on the cylinder head.



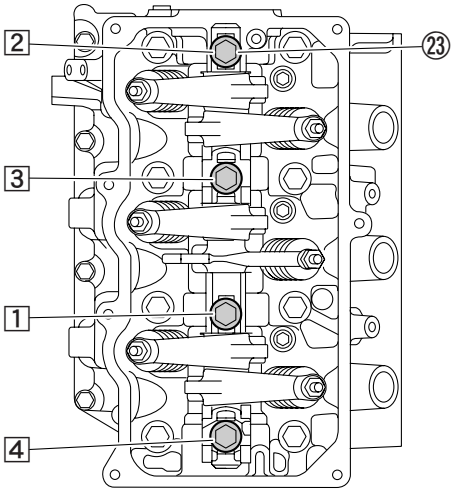
8. Install the rocker arms ⑯, ⑰, and washers ⑱ into the rocker arm shaft ⑲, and then install the tensioners ⑳, the stoppers ㉑, the washers ㉒, and the rocker arm shaft bolts ㉓.



TIP:

Make sure that the arrow marks ⓒ on the tensioners ⑳ are facing towards the driven sprocket.

9. Gradually tighten the rocker arm shaft bolts ㉓ to the specified torque and in the sequence numbers (1, 2, · · ·).



Rocker arm shaft bolt ㉓:
18 N·m (1.8 kgf·m, 13.3 ft·lb)

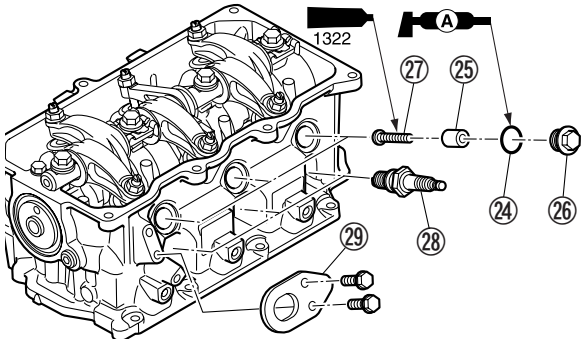
10. Install new O-rings ㉔ and the cylinder head anodes ㉕ to the cylinder head anode plugs ㉖, and then tighten the cylinder head anode screws ㉗ to the specified torque.

11. Tighten the cylinder head anode plugs ㉖ to the specified torque.

12. Install the spark plugs ㉘, and then tighten them to the specified torque.

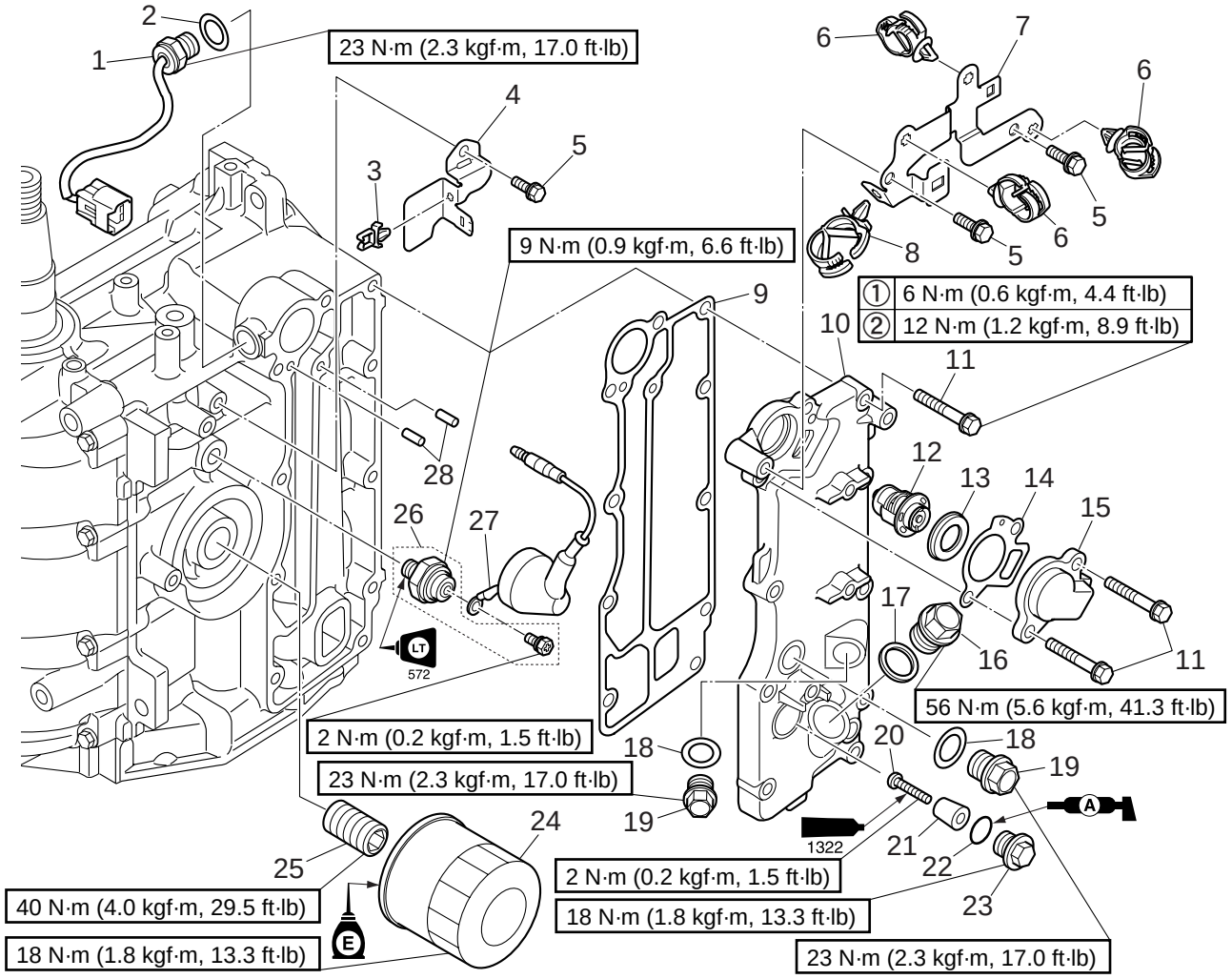
7

13. Install the engine hanger ㉙.

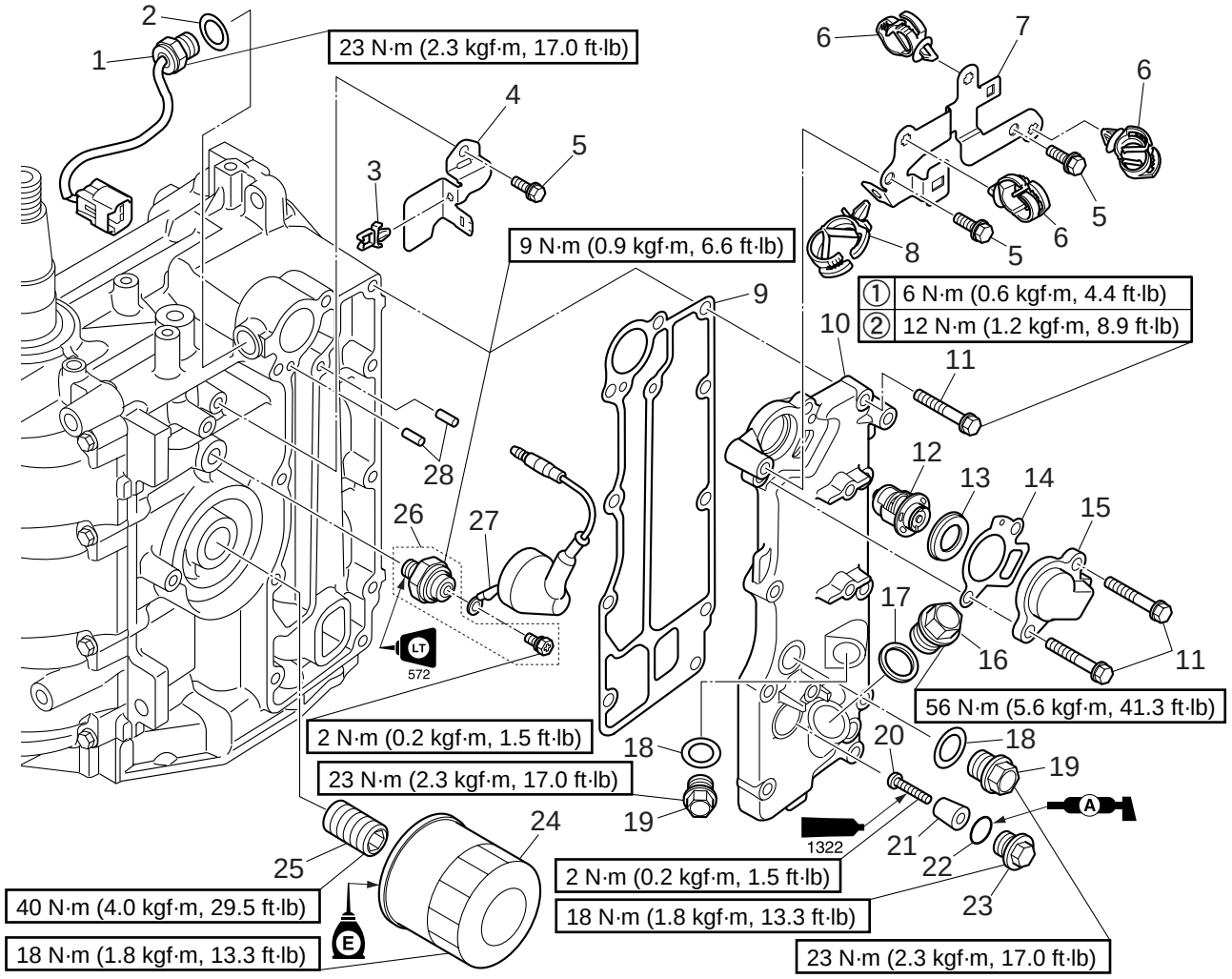


Cylinder head anode screw ㉗: 2 N·m (0.2 kgf·m, 1.5 ft·lb) Cylinder head anode plugs ㉖: 18 N·m (1.8 kgf·m, 13.3 ft·lb) Spark plug ㉘: 18 N·m (1.8 kgf·m, 13.3 ft·lb)

Exhaust cover


23 N·m (2.3 kgf·m, 17.0 ft·lb)
9 N·m (0.9 kgf·m, 6.6 ft·lb)
① 6 N·m (0.6 kgf·m, 4.4 ft·lb)
② 12 N·m (1.2 kgf·m, 8.9 ft·lb)
56 N·m (5.6 kgf·m, 41.3 ft·lb)
2 N·m (0.2 kgf·m, 1.5 ft·lb)
23 N·m (2.3 kgf·m, 17.0 ft·lb)
2 N·m (0.2 kgf·m, 1.5 ft·lb)
18 N·m (1.8 kgf·m, 13.3 ft·lb)
23 N·m (2.3 kgf·m, 17.0 ft·lb)
40 N·m (4.0 kgf·m, 29.5 ft·lb)
18 N·m (1.8 kgf·m, 13.3 ft·lb)
LT
572
1322
A
E

No.	Part name	Q'ty	Remarks
1	Thermo sensor	1	
2	Gasket	1	**Not reusable**
3	Clamp	1	
4	Plate	1	
5	Bolt	3	M6 × 16 mm
6	Clamp	3	
7	Bracket	1	
8	Clamp	1	
9	Gasket	1	**Not reusable**
10	Exhaust cover	1	
11	Bolt	10	M6 × 35 mm
12	Thermostat	1	
13	Gasket	1	**Not reusable**
14	Gasket	1	**Not reusable**
15	Thermostat cover	1	
16	Plug	1	M18 × 17 mm
17	Gasket	1	**Not reusable**


23 N·m (2.3 kgf·m, 17.0 ft·lb)
9 N·m (0.9 kgf·m, 6.6 ft·lb)
① 6 N·m (0.6 kgf·m, 4.4 ft·lb)
② 12 N·m (1.2 kgf·m, 8.9 ft·lb)
56 N·m (5.6 kgf·m, 41.3 ft·lb)
2 N·m (0.2 kgf·m, 1.5 ft·lb)
23 N·m (2.3 kgf·m, 17.0 ft·lb)
2 N·m (0.2 kgf·m, 1.5 ft·lb)
18 N·m (1.8 kgf·m, 13.3 ft·lb)
23 N·m (2.3 kgf·m, 17.0 ft·lb)
40 N·m (4.0 kgf·m, 29.5 ft·lb)
18 N·m (1.8 kgf·m, 13.3 ft·lb)
LT
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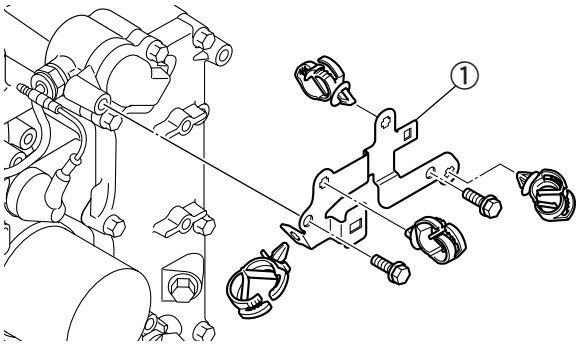
E

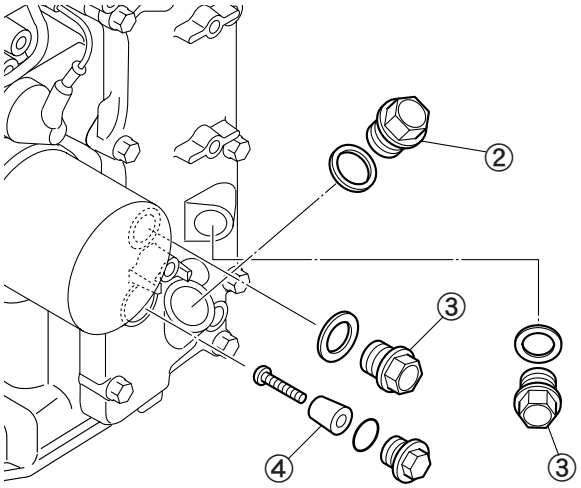
No.	Part name	Q'ty	Remarks
18	Gasket	2	**Not reusable**
19	Plug	2	M14 × 12 mm
20	Screw	1	M5 × 24 mm
21	Anode	1	
22	O-ring	1	**Not reusable**
23	Anode plug	1	
24	Oil filter	1	
25	Union bolt	1	
26	Oil pressure switch	1	
27	Oil pressure switch lead	1	
28	Dowel	2	

Removing the exhaust cover

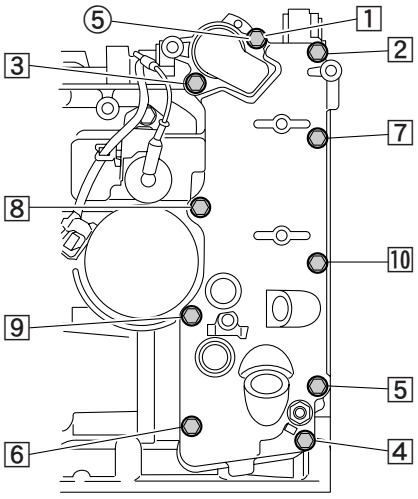
1. Remove the bracket ①.



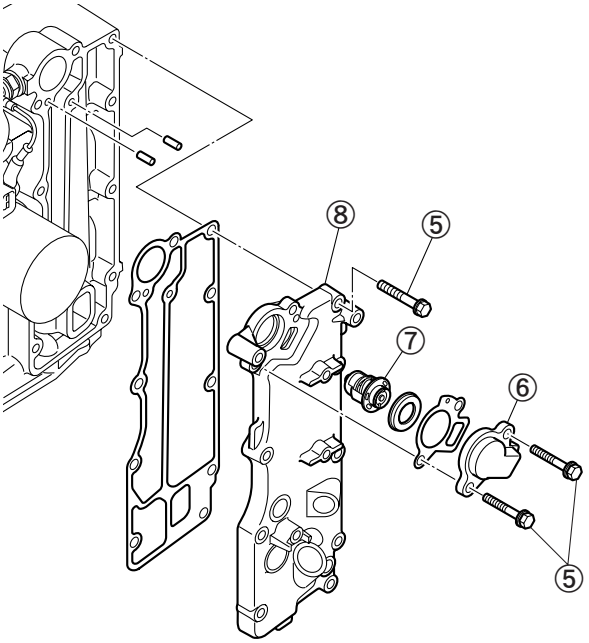
2. Remove the exhaust cover plugs ②, ③, and the exhaust cover anode ④.



3. Loosen the exhaust cover bolts ⑤ in the sequence numbers (1, 2, · · ·).

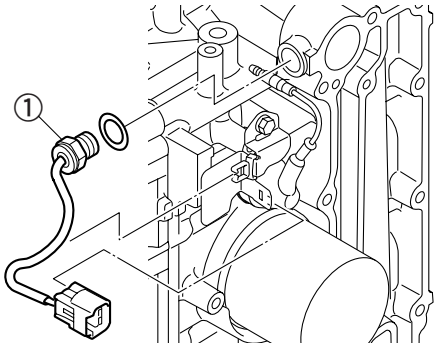


4. Remove the exhaust cover bolts ⑤, the thermostat cover ⑥, the thermostat ⑦, and the exhaust cover ⑧.



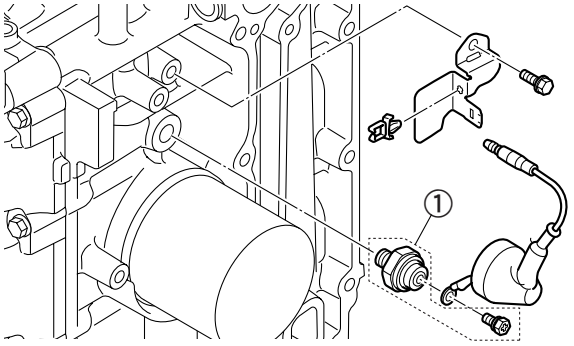
Removing the thermo sensor

1. Remove the thermo sensor ①.



Removing the oil pressure switch

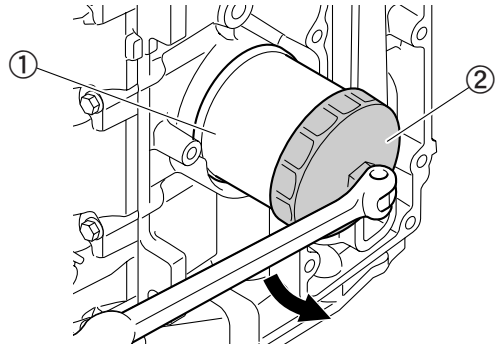
1. Remove the oil pressure switch ①.



Removing the oil filter

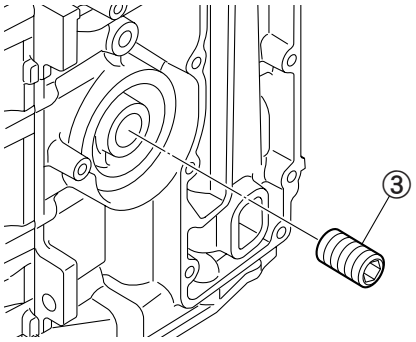
1. Remove the oil filter ①.

7



Oil filter wrench ②: 90890-01426

2. Remove the oil filter union bolt ③.

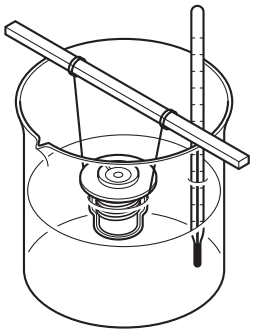


Checking the exhaust cover anode

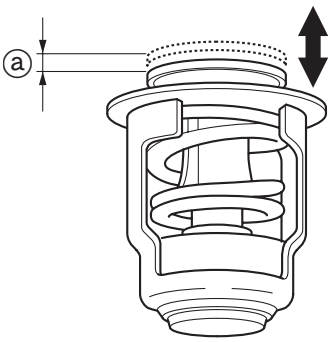
1. Check the anodes. Clean if there is grease, oil, or scales. ***NOTICE:*** **Do not grease, oil, or paint the anodes.**

Checking the thermostat

1. Suspend the thermostat in a container with water.
2. Place a thermometer in the water and slowly heat the water.



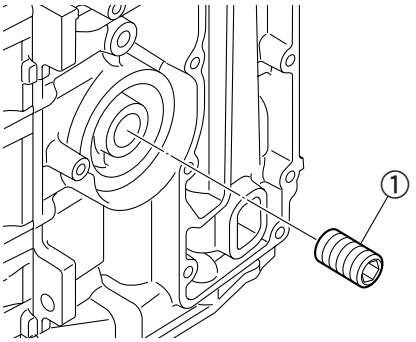
3. Measure the thermostat valve opening ⓐ at the specified water temperatures. Replace if out of specification.



Water temperature	Valve opening ⓐ
58–62 °C (136–144 °F)	starts opening
above 70 °C (158 °F)	3.0 mm (0.12 in) or above

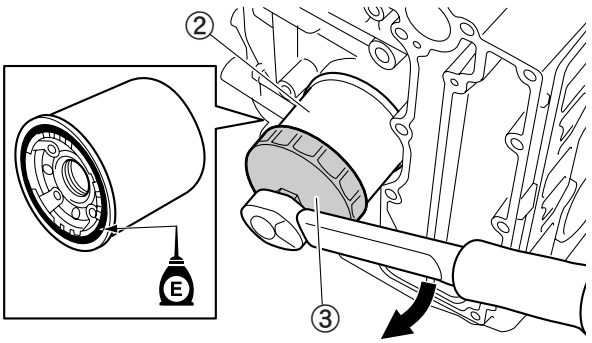
Installing the oil filter

1. Install the oil filter union bolt ①, and then tighten it to the specified torque.



Oil filter union bolt ①:
40 N·m (4.0 kgf·m, 29.5 ft·lb)

2. Install the oil filter ②, and then tighten it to the specified torque.



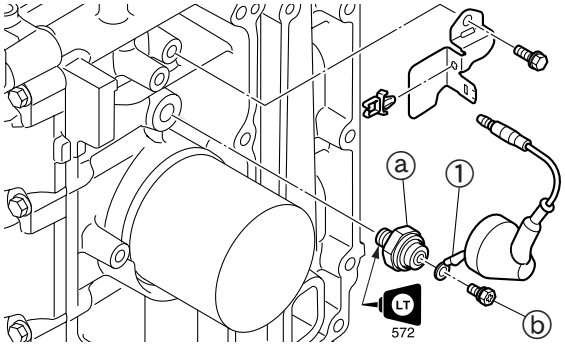
Oil filter wrench ③: 90890-01426

Oil filter ②: 18 N·m (1.8 kgf·m, 13.3 ft·lb)

Installing the oil pressure switch

1. Install the oil pressure switch ⓐ to the specified torque.

2. Install the oil pressure switch lead ①, and then tighten the oil pressure switch bolt ⓑ to the specified torque.

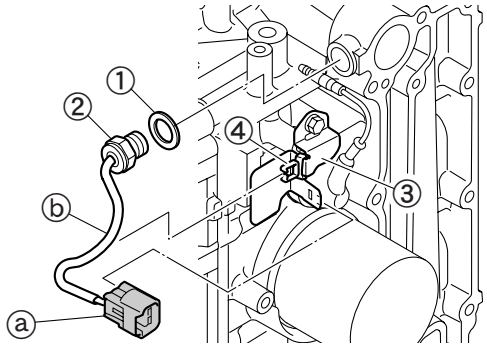


Oil pressure switch ⓐ: 9 N·m (0.9 kgf·m, 6.6 ft·lb) Oil pressure switch bolt ⓑ: 2 N·m (0.2 kgf·m, 1.5 ft·lb)

Installing the thermo sensor

1. Install a new gasket ① and the thermo sensor ②, and then tighten the thermo sensor ② to the specified torque.

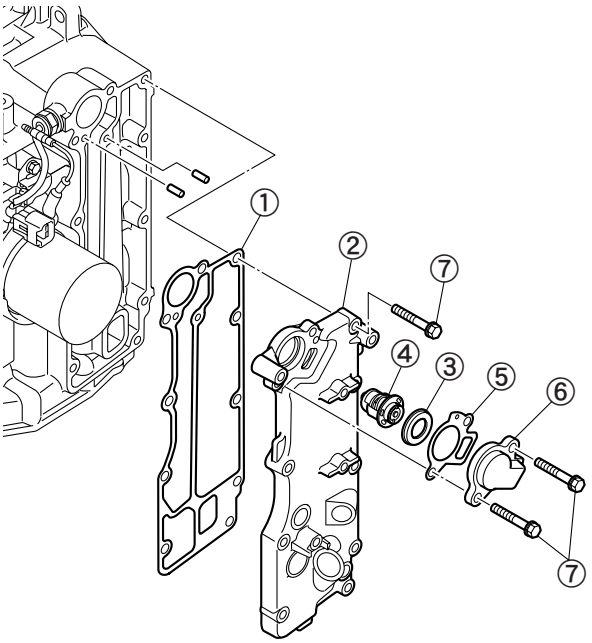
2. Install the thermo sensor coupler ⓐ to the bracket ③, and the thermo sensor lead ⓑ to the clamp ④.



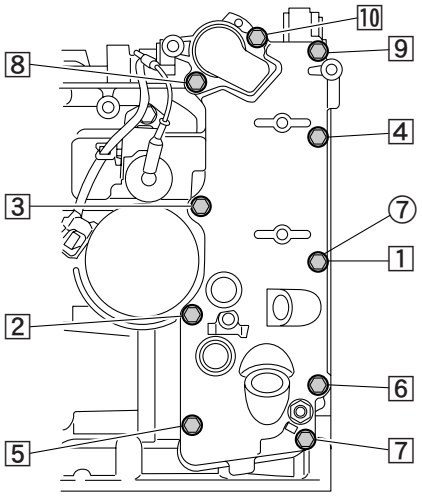
Thermo sensor ②: 23 N·m (2.3 kgf·m, 17.0 ft·lb)

Installing the exhaust cover

1. Install a new gasket ①, the exhaust cover ②, a new gasket ③, the thermostat ④, a new gasket ⑤, the thermostat cover ⑥, and the exhaust cover bolts ⑦.



2. Tighten the exhaust cover bolts ⑦ to the specified torque in the sequence numbers (1, 2, · · ·) in 2 stages.



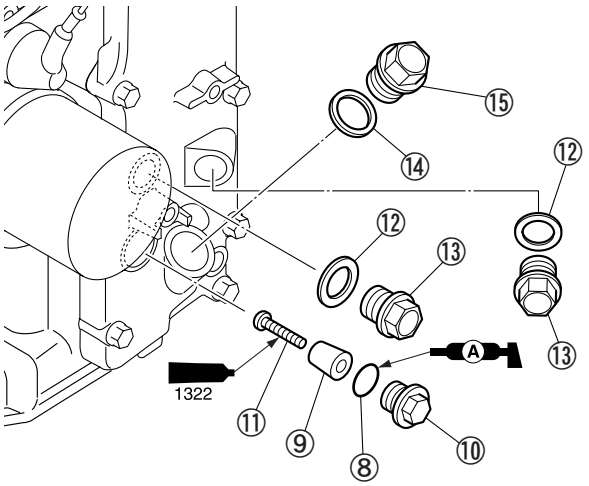
Exhaust cover bolt ⑦: 1st: 6 N·m (0.6 kgf·m, 4.4 ft·lb) 2nd: 12 N·m (1.2 kgf·m, 8.9 ft·lb)

3. Install a new O-ring ⑧ and the exhaust cover anode ⑨ to the exhaust cover anode plug ⑩, and then tighten the exhaust cover anode screw ⑪ to the specified torque.

4. Tighten the exhaust cover anode plug ⑩ to the specified torque.

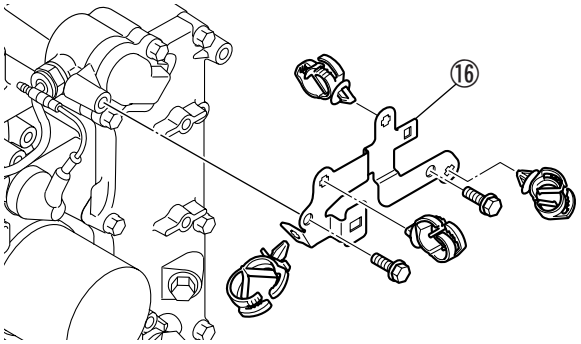
5. Install a new gaskets ⑫ and the exhaust cover plugs ⑬, and then tighten the exhaust cover plugs ⑬ to the specified torque.

6. Install a new gasket ⑭ and the exhaust cover plug ⑮, and then tighten the exhaust cover plug ⑮ to the specified torque.

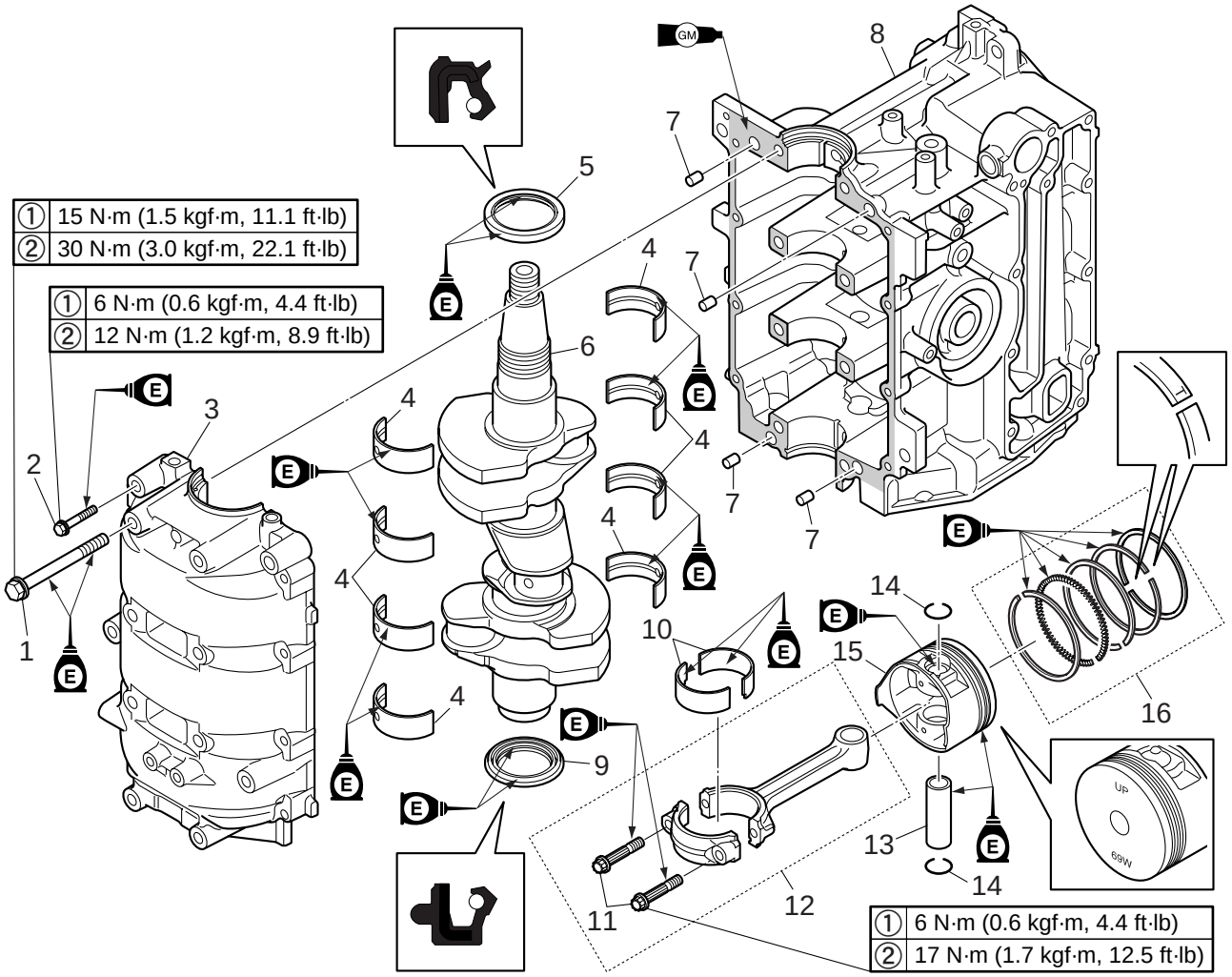


Exhaust cover anode screw ⑪: 2 N·m (0.2 kgf·m, 1.5 ft·lb) Exhaust cover anode plug ⑩: 18 N·m (1.8 kgf·m, 13.3 ft·lb) Exhaust cover plug ⑬ (M14): 23 N·m (2.3 kgf·m, 17.0 ft·lb) Exhaust cover plug ⑮ (M18): 56 N·m (5.6 kgf·m, 41.3 ft·lb)

7. Install the bracket ⑯.



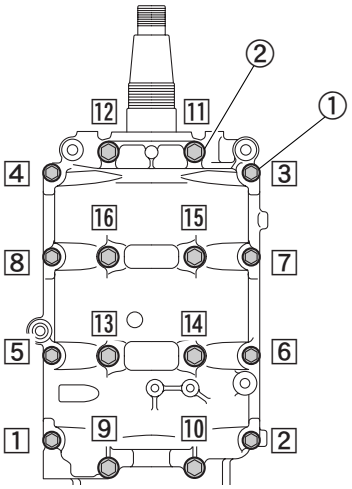
Cylinder block


① 15 N·m (1.5 kgf·m, 11.1 ft·lb)
② 30 N·m (3.0 kgf·m, 22.1 ft·lb)
① 6 N·m (0.6 kgf·m, 4.4 ft·lb)
② 12 N·m (1.2 kgf·m, 8.9 ft·lb)
① 6 N·m (0.6 kgf·m, 4.4 ft·lb)
② 17 N·m (1.7 kgf·m, 12.5 ft·lb)
GM
E
Up
69W

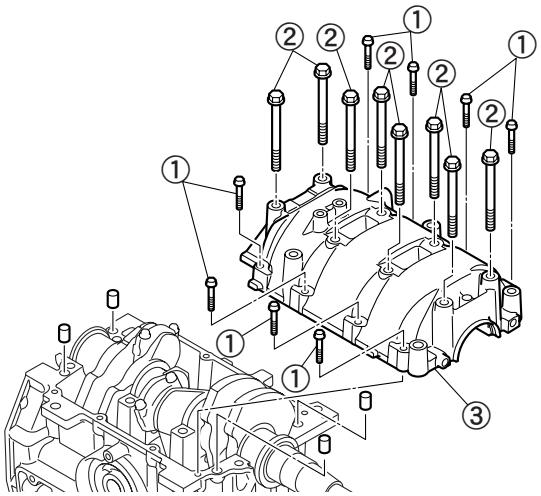
No.	Part name	Q'ty	Remarks
1	Bolt	8	M8 × 82 mm
2	Bolt	8	M6 × 35 mm
3	Crankcase	1	
4	Crankshaft journal bearing	8	
5	Oil seal	1	**Not reusable**
6	Crankshaft	1	
7	Dowel	4	
8	Cylinder block	1	
9	Oil seal	1	**Not reusable**
10	Crankpin bearing	6	
11	Bolt	6	**Not reusable** M6 × 30 mm
12	Connecting rod assembly	3	
13	Piston pin	3	
14	Clip	6	**Not reusable**
15	Piston	3	
16	Piston ring set	3	

Disassembling the cylinder block

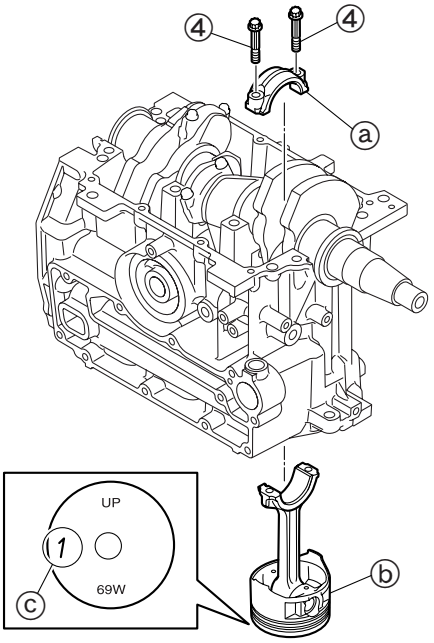
1. Loosen the crankcase bolts ① and ② in the sequence numbers (1, 2, · · ·).



2. Remove the crankcase bolts ① and ②, and then remove the crankcase ③.



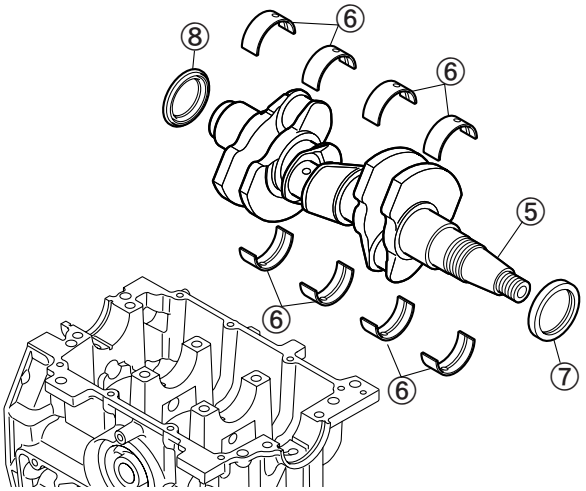
3. Remove the connecting rod bolts ④ and the connecting rod caps ⓐ, and then remove the connecting rod and the piston assemblies ⓑ.



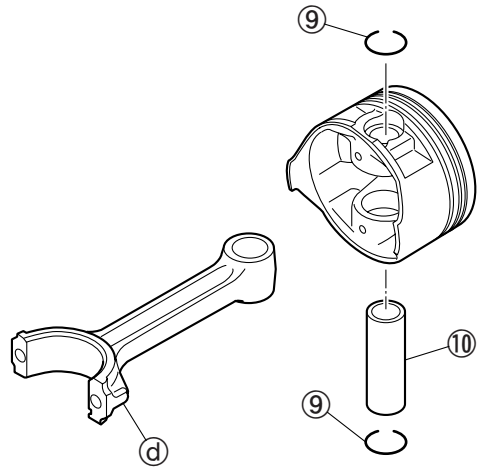
TIP:

- Make sure to keep the crankpin bearings in their original groups.
- Mark each piston with an identification number ⓒ of the corresponding cylinder.
- Do not mix the connecting rods and caps. Keep them organized in their proper groups.

4. Remove the crankshaft ⑤, the crankshaft journal bearings ⑥, and the oil seals ⑦ and ⑧.

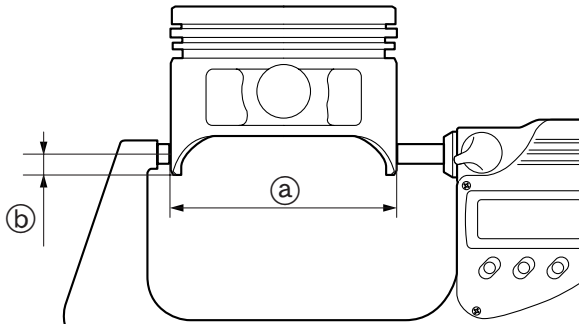


5. Remove the piston pin clips ⑨ and the piston pin ⑩, and then remove the connecting rod ⓓ.



Checking the piston diameter

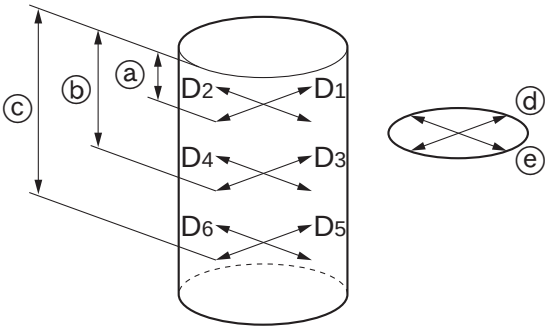
1. Measure the piston outside diameter ⓐ at the specified measuring point ⓑ. Replace if out of specification.



Piston diameter ⓐ:
64.950–64.965 mm
(2.5571–2.5577 in)
Measuring point ⓑ:
5.0 mm (0.20 in) above the bottom of the piston skirt
Oversize piston diameter:
Oversize 1st:
65.200–65.215 mm
(2.5669–2.5675 in)
Oversize 2nd:
65.450–65.465 mm
(2.5768–2.5774 in)

Checking the cylinder bore

1. Measure the cylinder bore (D_1–D_6) at measuring points ⓐ, ⓑ, and ⓒ, and in direction ⓓ (D_1, D_3, D_5), parallel to the crankshaft, and direction ⓔ (D_2, D_4, D_6), at a right angle to the crankshaft.

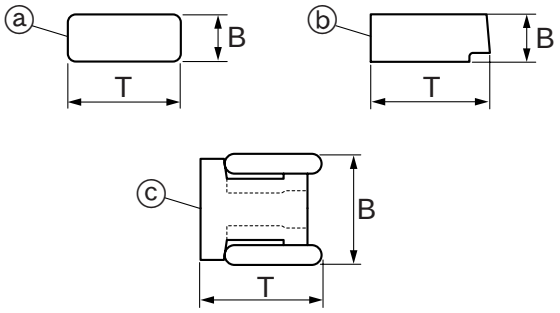


ⓐ 10.0 mm (0.39 in)
ⓑ 48.0 mm (1.89 in)
ⓒ 85.0 mm (3.35 in)

Cylinder bore (D_1–D_6):
65.000–65.015 mm
(2.5591–2.5596 in)

Checking the piston ring

1. Measure the piston ring dimensions B and T. Replace the piston ring set if out of specification.



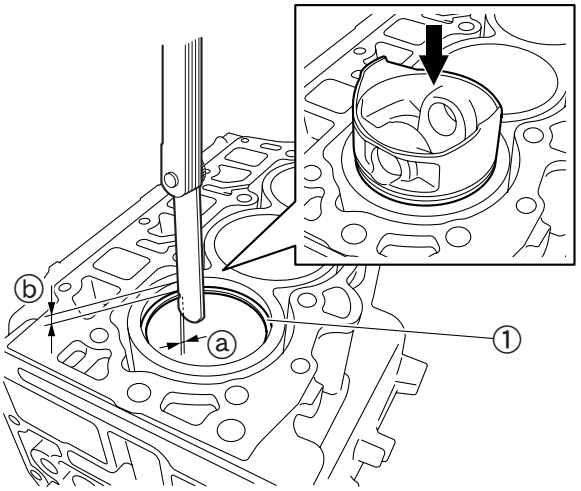
Piston ring dimensions:
Top ring ⓐ:
B: 1.17–1.19 mm (0.0461–0.0469 in)
T: 2.30–2.50 mm (0.0906–0.0984 in)
Second ring ⓑ:
B: 1.47–1.49 mm (0.0579–0.0587 in)
T: 2.60–2.80 mm (0.1024–0.1102 in)
Oil ring ⓒ:
B: 2.36–2.48 mm (0.0929–0.0976 in)
T: 2.75 mm (0.1083 in)

7

Checking the piston ring end gap

1. Level the piston ring ① in the cylinder with a piston crown.

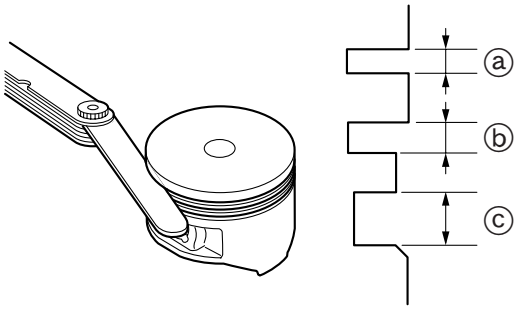
2. Check the piston ring end gap ⓐ at the specified measuring point ⓑ.



Piston ring end gap ⓐ (reference data):
Top ring:
0.15–0.30 mm (0.0059–0.0118 in)
Second ring:
0.30–0.50 mm (0.0118–0.0197 in)
Oil ring:
0.20–0.70 mm (0.0079–0.0276 in)
Measuring point ⓑ: 10.0 mm (0.39 in)

Checking the piston ring groove

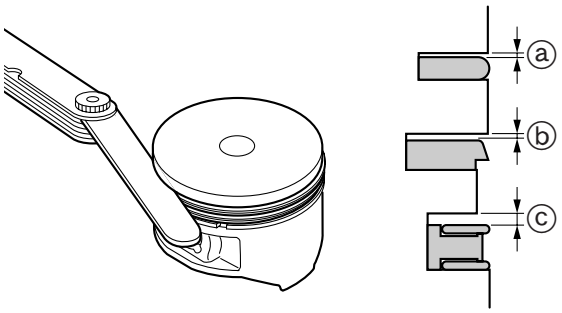
1. Measure the piston ring grooves. Replace if out of specification.



Piston ring groove:
Top ring ⓐ:
1.21–1.23 mm (0.0476–0.0484 in)
Second ring ⓑ:
1.51–1.53 mm (0.0594–0.0602 in)
Oil ring ⓒ:
2.52–2.54 mm (0.0992–0.1000 in)

Checking the piston ring side clearance

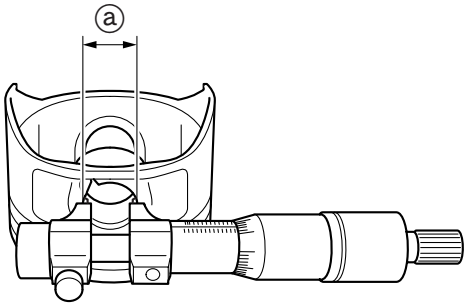
1. Measure the piston ring side clearance. Replace the piston and piston ring set if out of specification.



Piston ring side clearance:
Top ring ⓐ:
0.02–0.06 mm (0.0008–0.0024 in)
Second ring ⓑ:
0.02–0.06 mm (0.0008–0.0024 in)
Oil ring ⓒ:
0.04–0.18 mm (0.0016–0.0071 in)

Checking the piston pin boss inside diameter

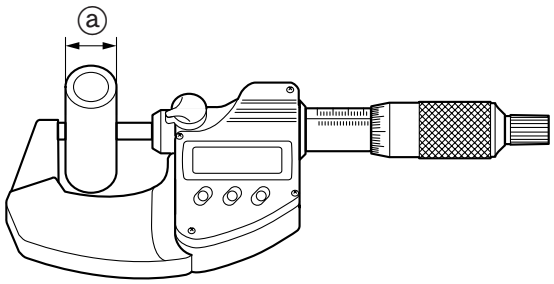
1. Measure the piston pin boss inside diameter. Replace if out of specification.



Piston pin boss inside diameter ⓐ:
15.974–15.985 mm
(0.6289–0.6293 in)

Checking the piston pin

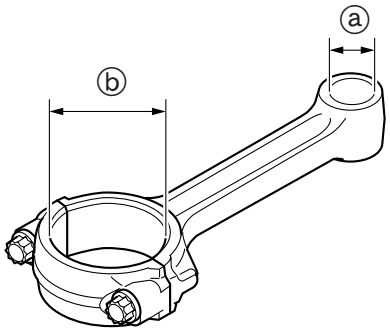
1. Measure the piston pin outside diameter. Replace if out of specification.



Piston pin outside diameter ⓐ:
15.965–15.970 mm
(0.6285–0.6287 in)

Checking the connecting rod small end and big end inside diameter

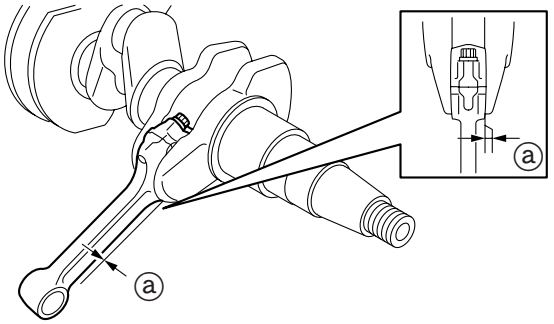
1. Measure the connecting rod small end inside diameter ⓐ and big end inside diameter ⓑ. Replace the connecting rod assembly if out of specification.



Connecting rod small end inside diameter ⓐ:
15.985–15.998 mm
(0.6293–0.6298 in)
Connecting rod big end inside diameter ⓑ:
36.000–36.024 mm
(1.4173–1.4183 in)

Checking the connecting rod big end side clearance

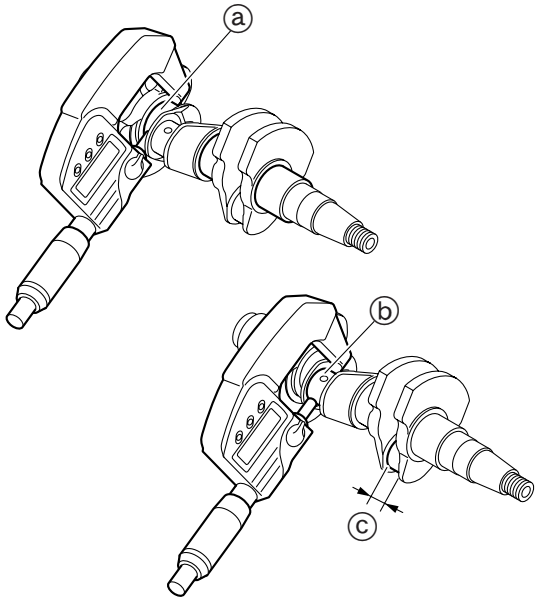
1. Measure the connecting rod big end side clearance ⓐ. Replace the connecting rod or crankshaft, or both if out of specification.



Connecting rod big end side clearance ⓐ:
0.05–0.22 mm (0.0020–0.0087 in)

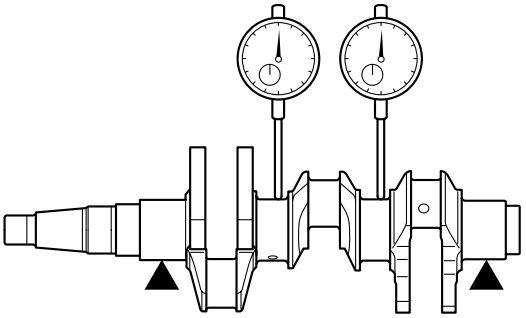
Checking the crankshaft

1. Measure the crankshaft journal diameter ⓐ, the crankpin diameter ⓑ, and the crankpin width ⓒ. Replace if out of specification.



Crankshaft journal diameter ⓐ:
42.984–43.000 mm
(1.6923–1.6929 in)
Crankpin diameter ⓑ:
32.984–33.000 mm
(1.2986–1.2992 in)
Crankpin width ⓒ:
21.00–21.07 mm (0.8268–0.8295 in)

2. Measure the crankshaft runout. Replace if above specification.

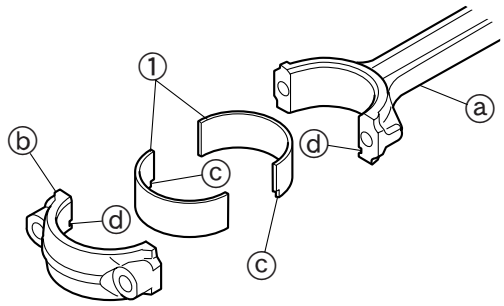


Crankshaft runout: 0.03 mm (0.0012 in)

Checking the crankpin oil clearance

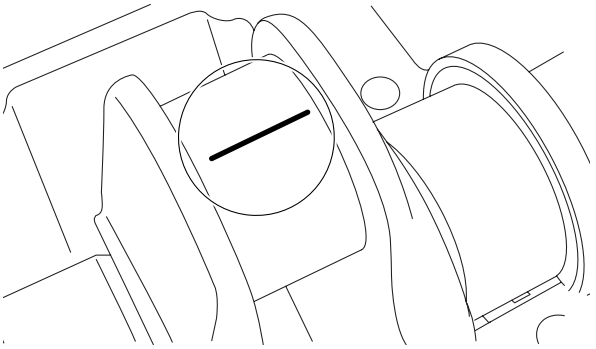
1. Clean the crankpin bearings, the connecting rod, the connecting rod cap, and the crankpin.

2. Install the crankpin bearings ① into the connecting rod ⓐ and the connecting rod cap ⓑ.



TIP:
- Install the crankpin bearings in their original positions.
- Install the protrusions ⓒ of the crankpin bearing into the grooves ⓓ on the connecting rod ⓐ and connecting rod cap ⓑ.

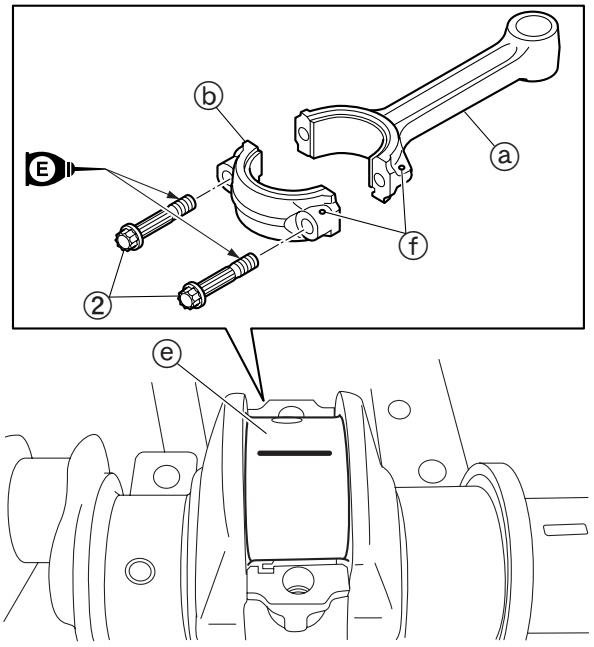
3. Put a piece of Plastigauge (PG-1) onto the crankpin, parallel to the crankshaft.



TIP:
Do not put the Plastigauge (PG-1) over the oil hole in the crankpin of the crankshaft.

4. Install the connecting rod ⓐ and the connecting rod cap ⓑ to the crankpin ⓔ.

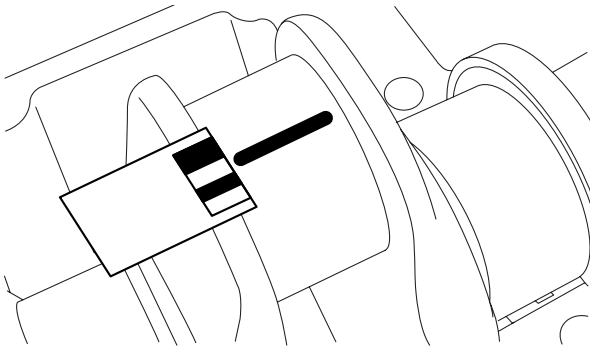
5. Tighten the connecting rod bolts ② to the specified torque in 2 stages.



Connecting rod bolt ②:
1st: 6 N·m (0.6 kgf·m, 4.4 ft·lb)
2nd: 17 N·m (1.7 kgf·m, 12.5 ft·lb)

TIP:
- Make sure that the protrusions ⓕ on the connecting rod ⓐ and connecting rod cap ⓑ face towards the flywheel magnet side of the crankshaft.
- Reuse the removed connecting rod bolts ② when checking the oil clearance.
- Do not turn the connecting rod ⓐ until the crankpin oil clearance measurement has been completed.

6. Remove the connecting rod cap, and then measure the width of the compressed Plastigauge (PG-1) on each crankpin. Replace the crankpin bearing if out of specification.

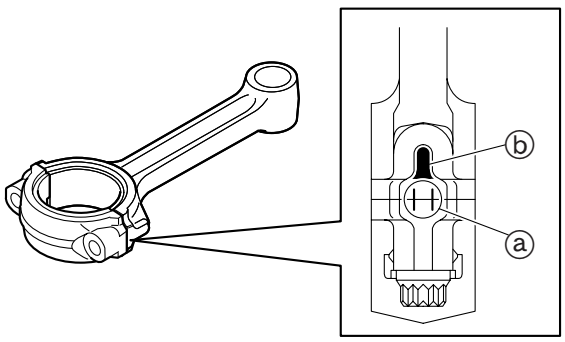


Crankpin oil clearance:
0.016–0.040 mm (0.0006–0.0016 in)

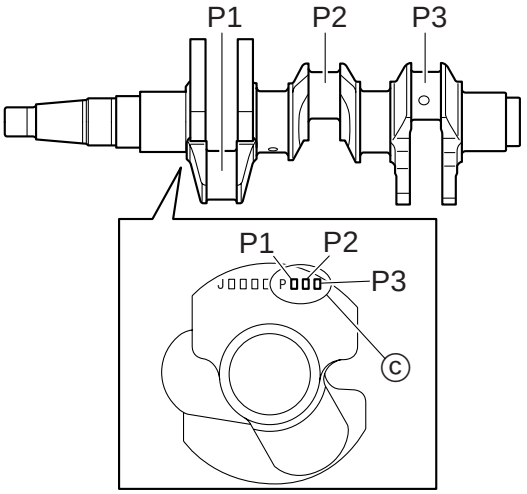
Selecting the crankpin bearing

1. When replacing the crankpin bearing, select the suitable bearing as follows.

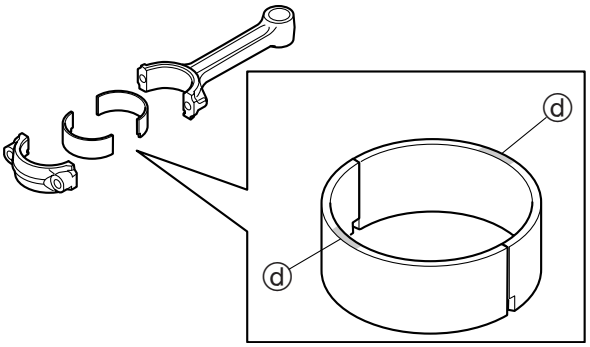
2. Check the connecting rod mark ⓐ or painted color ⓑ.



3. Check the crankpin mark ⓒ.



4. Select the bearing color ⓓ for the crankpin bearing from the table.



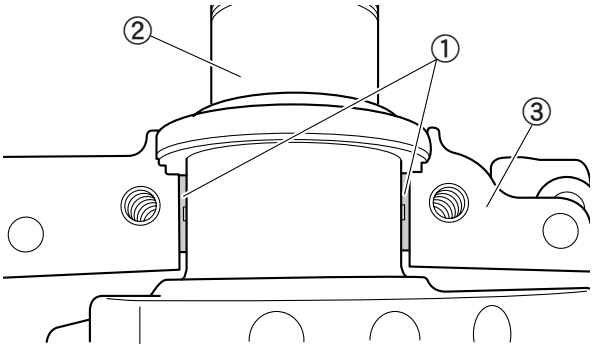
Crankpin bearing selection table at 20 °C (68 °F)		
Connecting rod mark ⓐ/color ⓑ	Crankpin mark ⓒ	Bearing color ⓓ
|/Red	A	Yellow
	B	Red
||/Blue	A	
	B	Pink
|||/Yellow	A	
	B	Green

Checking the crankshaft journal oil clearance

1. Clean the crankshaft journal bearings, the crankshaft journals, and the bearing portions of the crankcase and the cylinder block.

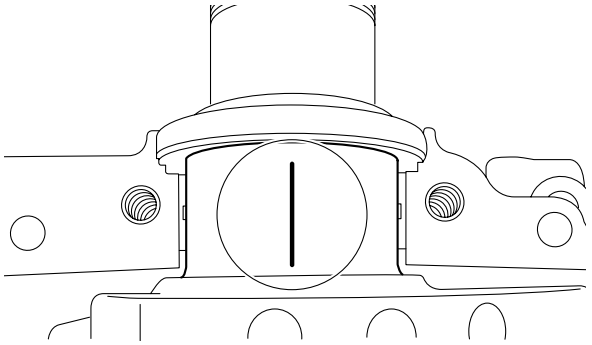
2. Place the cylinder block upside down.

3. Install the crankshaft journal bearings ① and the crankshaft ② into the cylinder block ③.



TIP:
Install the crankshaft journal bearings in their original positions.

4. Put a piece of Plastigauge (PG-1) onto the crankshaft journals, parallel to the crankshaft.

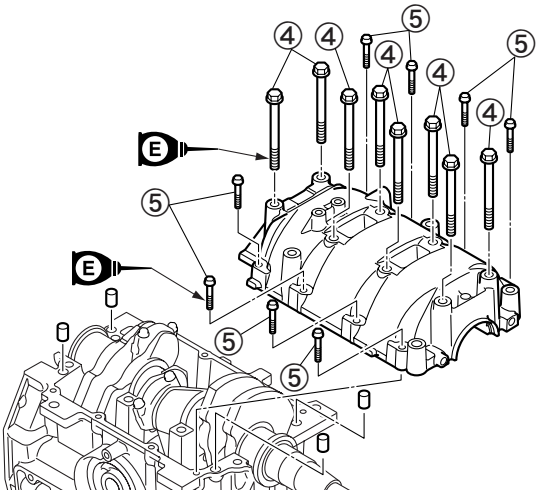


TIP:
Do not put the Plastigauge (PG-1) over the oil hole in the crankshaft journal.

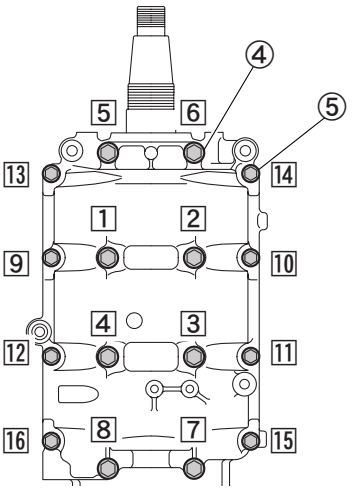
5. Install the crankshaft journal bearings into the crankcase.

TIP:
Install the crankshaft journal bearings in their original positions.

6. Install the crankcase onto the cylinder block, and then install the crankcase bolts ④ and ⑤.



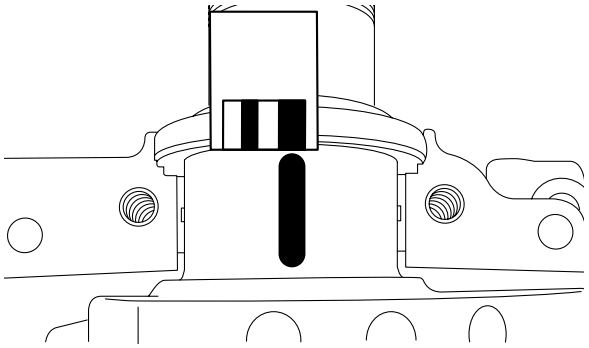
7. Tighten the M8 bolts ④ 1–8 to the specified torque in 2 stages, and then tighten the M6 bolts ⑤ 9–16 to the specified torque in 2 stages.



Crankcase bolt ④ 1–8 (M8):
1st: 15 N·m (1.5 kgf·m, 11.1 ft·lb)
2nd: 30 N·m (3.0 kgf·m, 22.1 ft·lb)
Crankcase bolt ⑤ 9–16 (M6):
1st: 6 N·m (0.6 kgf·m, 4.4 ft·lb)
2nd: 12 N·m (1.2 kgf·m, 8.9 ft·lb)

TIP:
Do not turn the crankshaft until the crankshaft journal oil clearance measurement has been completed.

8. Remove the crankcase, and then measure the width of the compressed Plastigauge (PG-1) on each crankshaft journal. Replace the crankshaft journal bearing if out of specification.



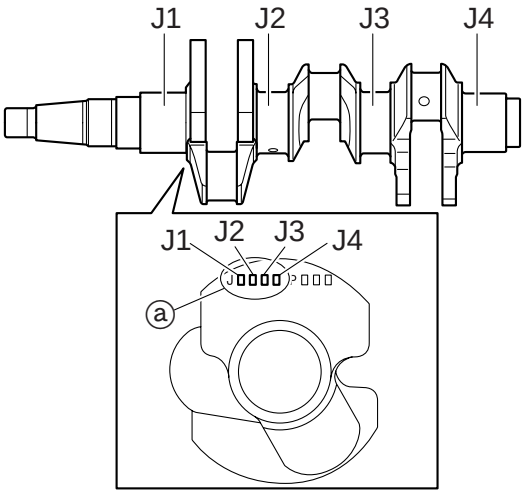
Crankshaft journal oil clearance:
0.012–0.036 mm (0.0005–0.0014 in)

TIP:
When loosening the crankcase bolts, loosen them in the opposite order used for tightening.

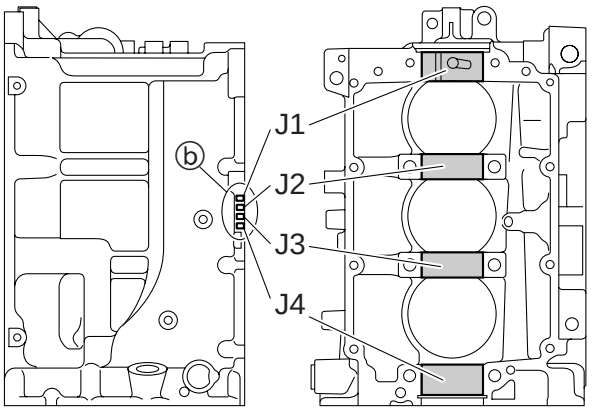
Selecting the crankshaft journal bearing

1. When replacing the crankshaft journal bearing, select the suitable bearing as follows.

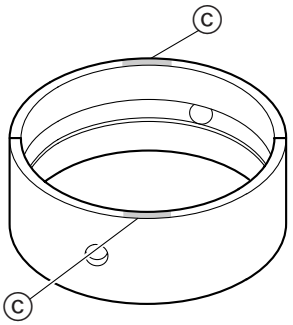
2. Check the crankshaft journal mark ⓐ.



3. Check the cylinder block mark ⓑ.



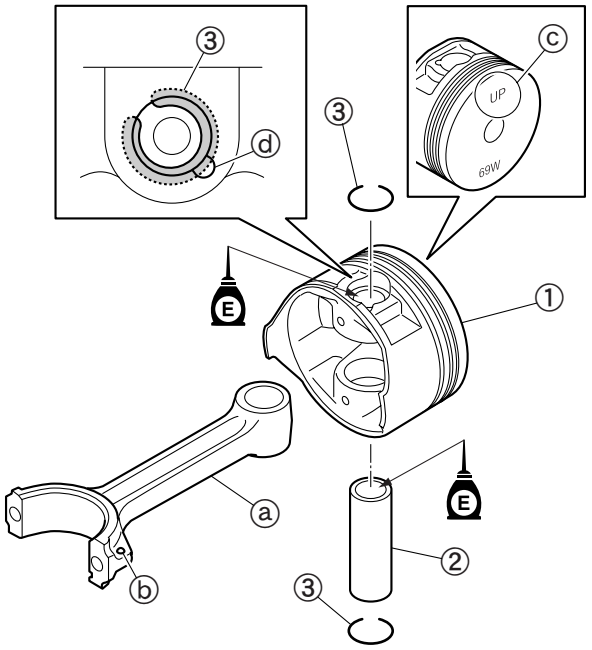
4. Select the bearing color ⓒ for the crankshaft journal bearing from the table.



Crankshaft journal bearing selection table at 20 °C (68 °F)		
Crankshaft journal mark ⓐ	Cylinder block mark ⓑ	Bearing color ⓒ
A	A	Yellow
	B	Red
B	A	
	B	Pink
C	A	
	B	Green

Assembling the cylinder block

1. Assemble the piston ①, the connecting rod ⓐ, the piston pin ②, and the piston pin clips ③. ***NOTICE:*** **Do not reuse the piston pin clips. Always replace them with new ones.**



TIP:

- Face the protrusions ⓑ on the connecting rod ⓐ in the same direction as the "UP" mark ⓒ on the piston ①.
- Do not align the piston pin clip end with the groove ⓓ of the piston.

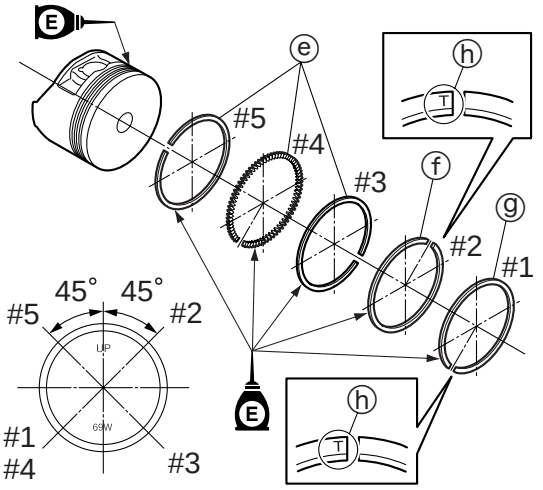
2. Install the oil rings ⓔ, the 2nd ring ⓕ, and the top ring ⓖ onto each piston.

TIP:

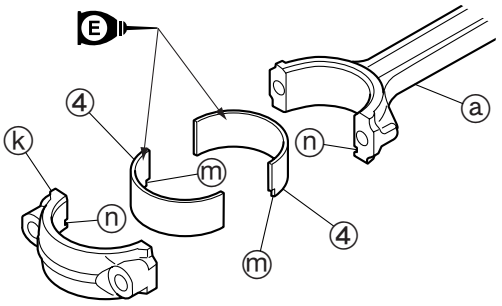
After installing the piston rings, check that they move smoothly.

3. Make sure that the "T" marks ⓗ of the 2nd ring ⓕ and the top ring ⓖ are facing upward.

4. Offset the piston ring end gaps. ***NOTICE:*** **Do not scratch the pistons or break the piston rings.**



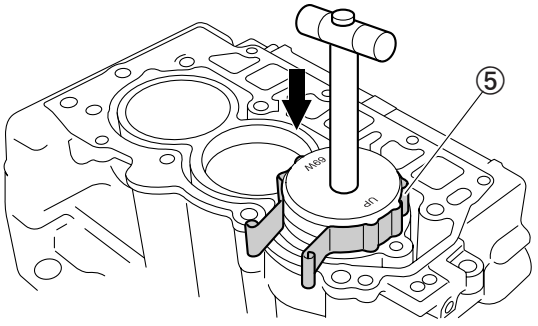
5. Install the crankpin bearings ④ into the connecting rod ⓐ and the connecting rod cap ⓚ.



TIP:

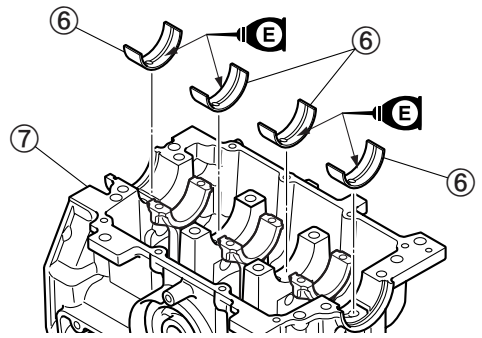
- Install the crankpin bearings in their original positions.
- Install the protrusions ⓜ of the crankpin bearing into the grooves ⓝ on the connecting rod ⓐ and connecting rod cap ⓚ.

6. Apply engine oil to the side of the piston, the piston rings and the cylinder wall, and then install the piston with the "UP" mark on the piston crown facing towards the flywheel magnet.



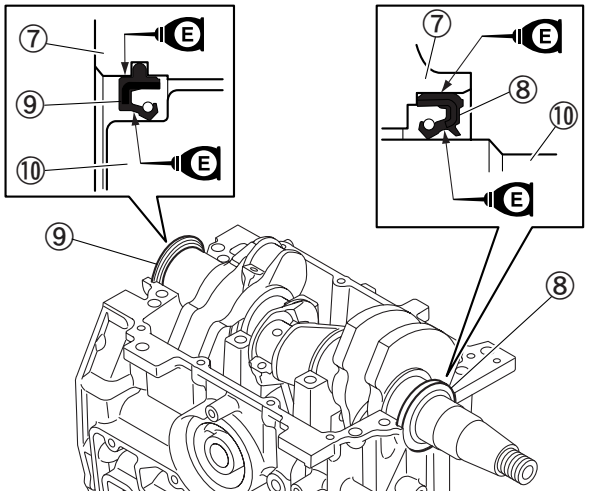
Piston slider ⑤: 90890-06529

7. Install the crankshaft journal bearings ⑥ into the cylinder block ⑦.



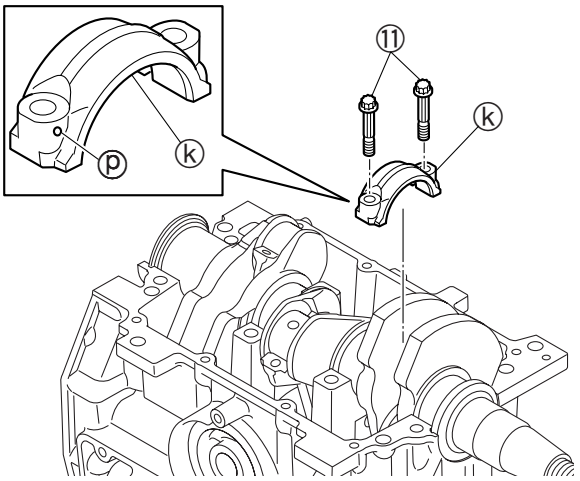
TIP:
Install the crankshaft journal bearings ⑥ in their original positions.

8. Install new oil seals ⑧ and ⑨ on the crankshaft ⑩, and then install the crankshaft onto the cylinder block ⑦.



TIP:
Make sure to install the oil seals into the cylinder block so that the oil seals are securely seated at the stepped area.

9. Install the connecting rod caps ⓚ to the connecting rods, and then tighten the new connecting rod bolts ⑪ to the specified torque in 2 stages.
NOTICE: **Do not reuse the connecting rod bolts. Always replace them with new ones.**

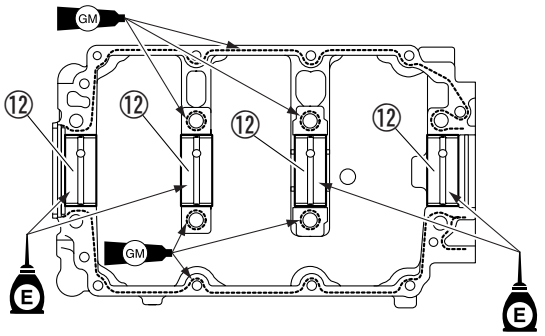


Connecting rod bolt ⑪:
1st: 6 N·m (0.6 kgf·m, 4.4 ft·lb)
2nd: 17 N·m (1.7 kgf·m, 12.5 ft·lb)

TIP:
- Make sure that the protrusions ⓟ on the connecting rod and connecting rod caps ⓚ face towards the flywheel magnet side of the crankshaft.
- After tightening the connecting rod cap bolts ⑪, check that the crankshaft rotates smoothly.

10. Install the crankshaft journal bearings ⑫ into the crankcase.

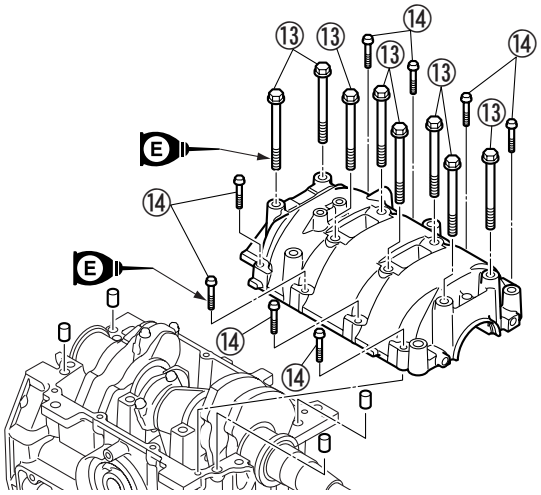
11. Apply sealant to the mating surface of the crankcase.



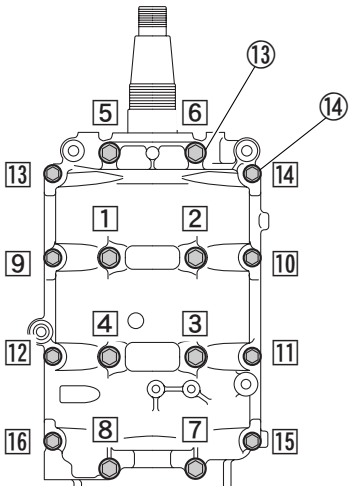
TIP:
- Install the crankshaft journal bearings ⑫ in their original positions.
- Do not get any sealant on the crankshaft journal bearings ⑫.

7

12. Install the crankcase onto the cylinder block, and then install the crankcase bolts ⑬ and ⑭.



13. Tighten the M8 bolts ⑬ 1–8 to the specified torque in 2 stages, and then tighten the M6 bolts ⑭ 9–16 to the specified torque in 2 stages.



Crankcase bolt ⑬ 1–8 (M8): 1st: 15 N·m (1.5 kgf·m, 11.1 ft·lb) 2nd: 30 N·m (3.0 kgf·m, 22.1 ft·lb) Crankcase bolt ⑭ 9–16 (M6): 1st: 6 N·m (0.6 kgf·m, 4.4 ft·lb) 2nd: 12 N·m (1.2 kgf·m, 8.9 ft·lb)

TIP:

After tightening the crankcase bolts, check that the crankshaft rotates smoothly.

— MEMO —

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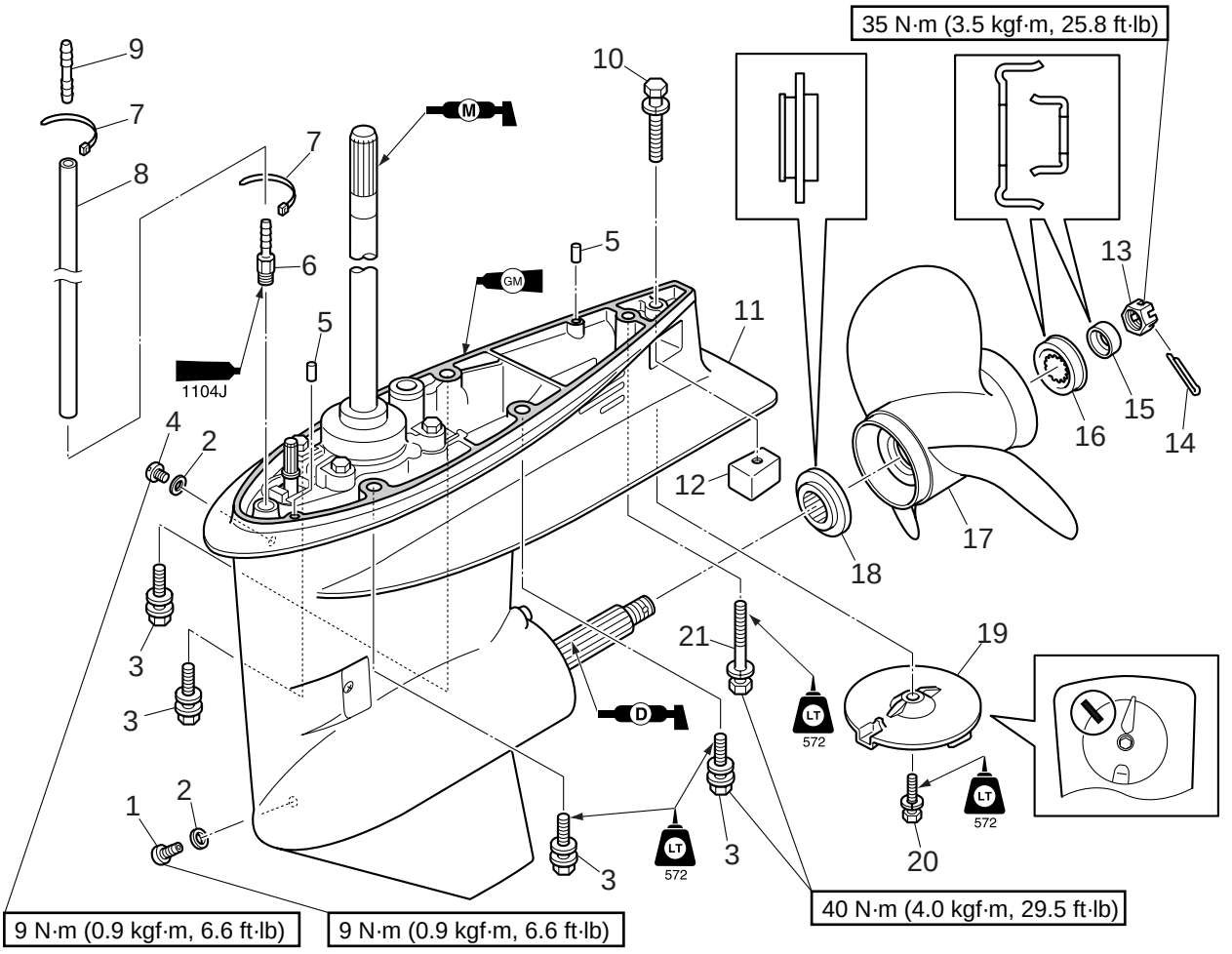
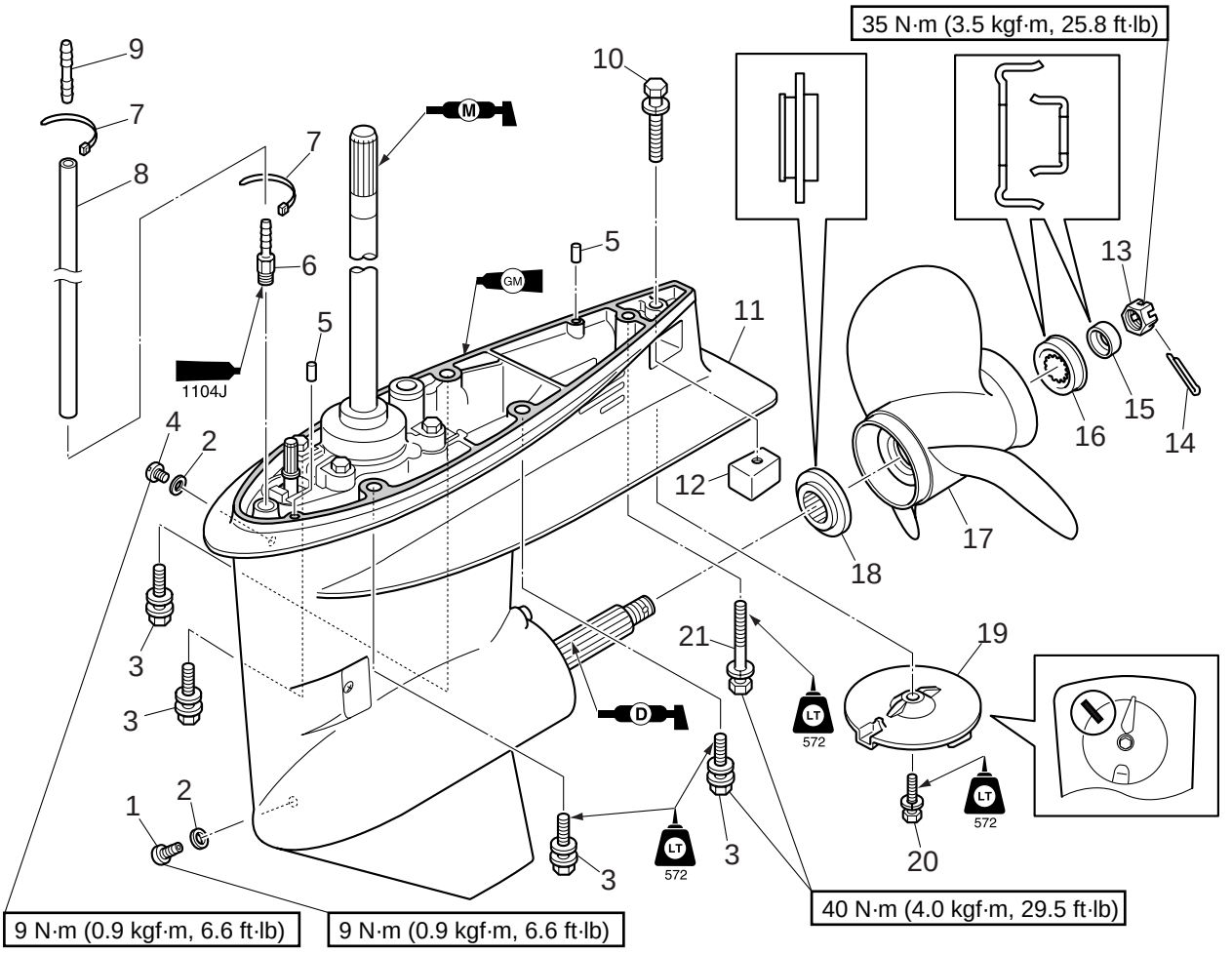
Lower unit



No.	Part name	Q'ty	Remarks
1	Drain screw	1	
2	Gasket	2	**Not reusable**
3	Bolt	4	M10 × 40 mm
4	Check screw	1	
5	Dowel	2	
6	Hose nipple	1	
7	Plastic tie	2	**Not reusable**
8	Hose	1	
9	Nipple	1	
10	Bolt	1	M8 × 35 mm
11	Lower unit	1	
12	Anode	1	
13	Propeller nut	1	
14	Cotter pin	1	**Not reusable**
15	Washer	1	
16	Washer	1	
17	Propeller	1	



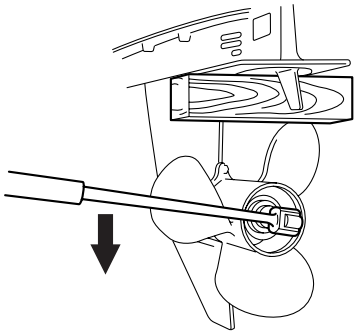
No.	Part name	Q'ty	Remarks
18	Spacer	1	
19	Trim tab	1	
20	Bolt	1	M8 × 25 mm
21	Bolt	1	M8 × 60 mm

Removing the lower unit

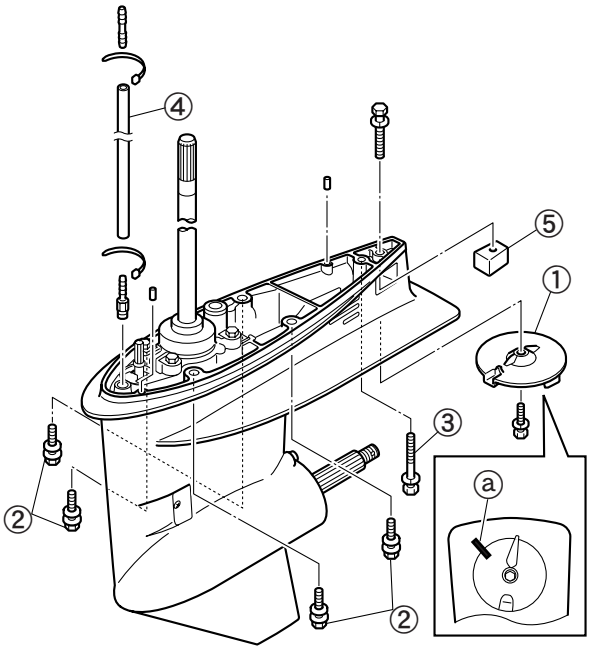
⚠ WARNING

- **Make sure to disconnect the battery cables from the battery, and then remove the clip from the engine shut-off switch.**
- **When removing the lower unit with the power unit installed, make sure to suspend the outboard motor. If the outboard motor is not suspended, it can fall suddenly and result in severe injuries.**
- **Do not hold the propeller with your hands when loosening or tightening it.**

1. Drain the gear oil.
2. Remove the cotter pin.
3. Set the gear shift to the N position, and place a block of wood between the anti-cavitation plate and the propeller to keep the propeller from turning, and then remove the propeller nut and the propeller.



4. Mark an alignment mark ⓐ on the trim tab ① and the lower case, and then remove the trim tab ①.
5. Remove the lower case mounting bolts ② and ③, and then remove the lower unit.
6. Remove the speedometer hose ④.
7. Remove the anode ⑤.



TIP:

When disassembling the lower unit, measure the backlash before disassembly. See "Measuring the forward and reverse gear backlash before disassembly" (8-25).

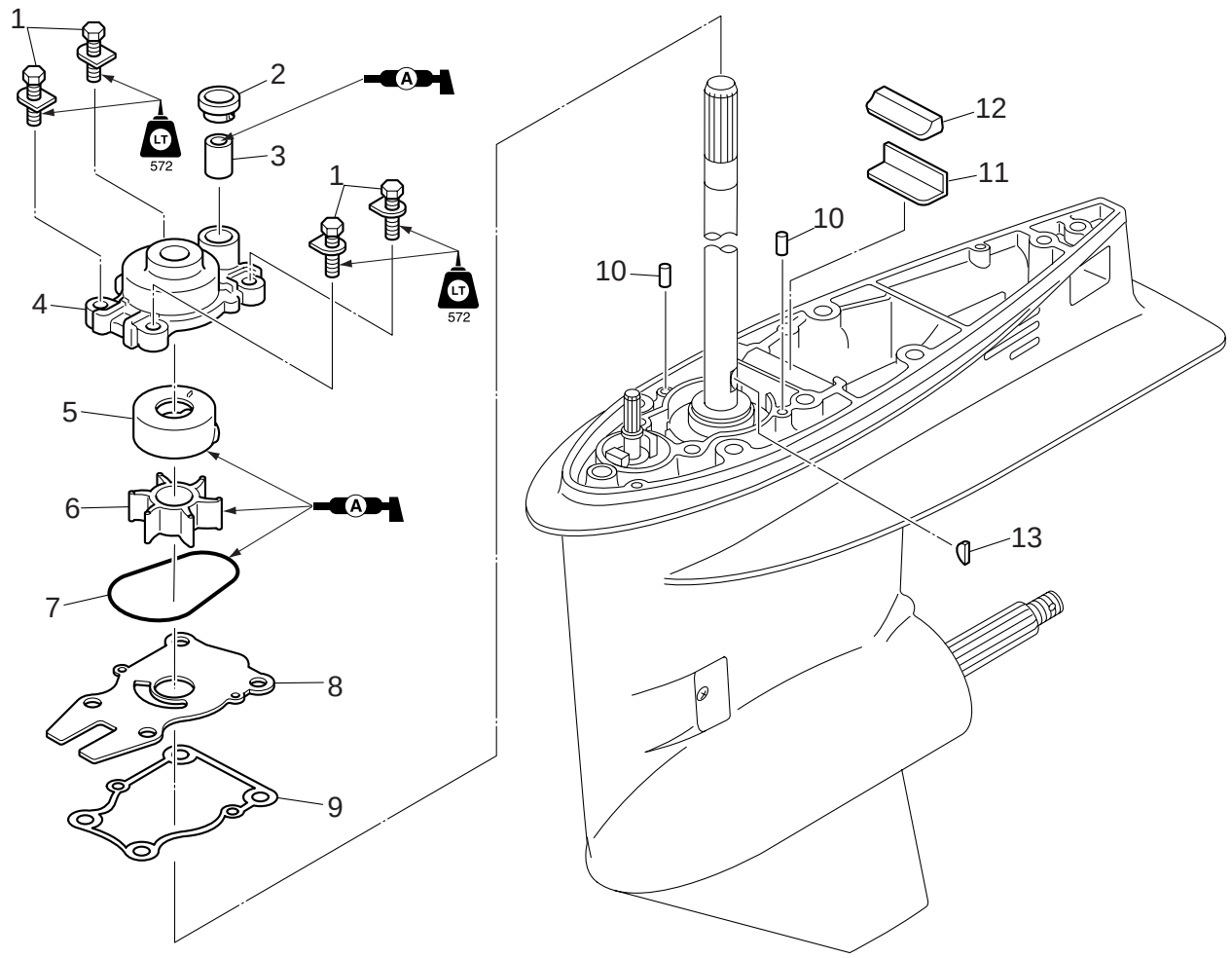
Checking the propeller

1. Check the propeller blades and splines. Replace the propeller if cracked, damaged, or worn.

Checking the lower unit anode

1. Check the anode and the trim tab. Clean the anode or the trim tab if there is grease, oil or scales. ***NOTICE:*** **Do not grease, oil, or paint the anode or the trim tab.**

Water pump



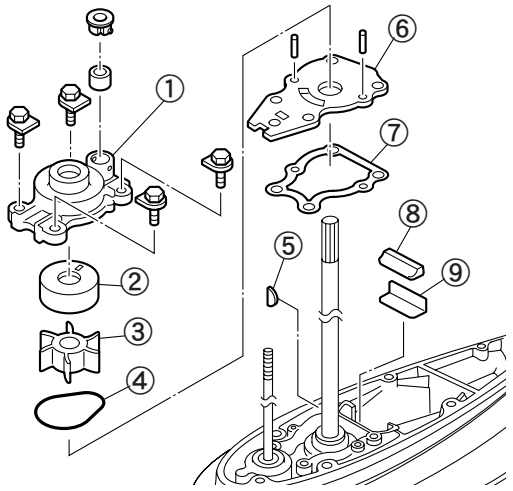
No.	Part name	Q'ty	Remarks
1	Bolt	4	M8 × 30 mm
2	Cover	1	
3	Seal	1	
4	Water pump housing	1	
5	Insert cartridge	1	
6	Impeller	1	
7	O-ring	1	**Not reusable**
8	Outer plate cartridge	1	
9	Gasket	1	**Not reusable**
10	Dowel	2	
11	Plate	1	
12	Rubber seal	1	
13	Woodruff key	1	

Removing the water pump

1. Remove the water pump housing ①, the insert cartridge ②, the impeller ③, the O-ring ④, and the Woodruff key ⑤.

2. Remove the outer plate cartridge ⑥ and the gasket ⑦.

3. Remove the rubber seal ⑧ and the plate ⑨.



Checking the water pump

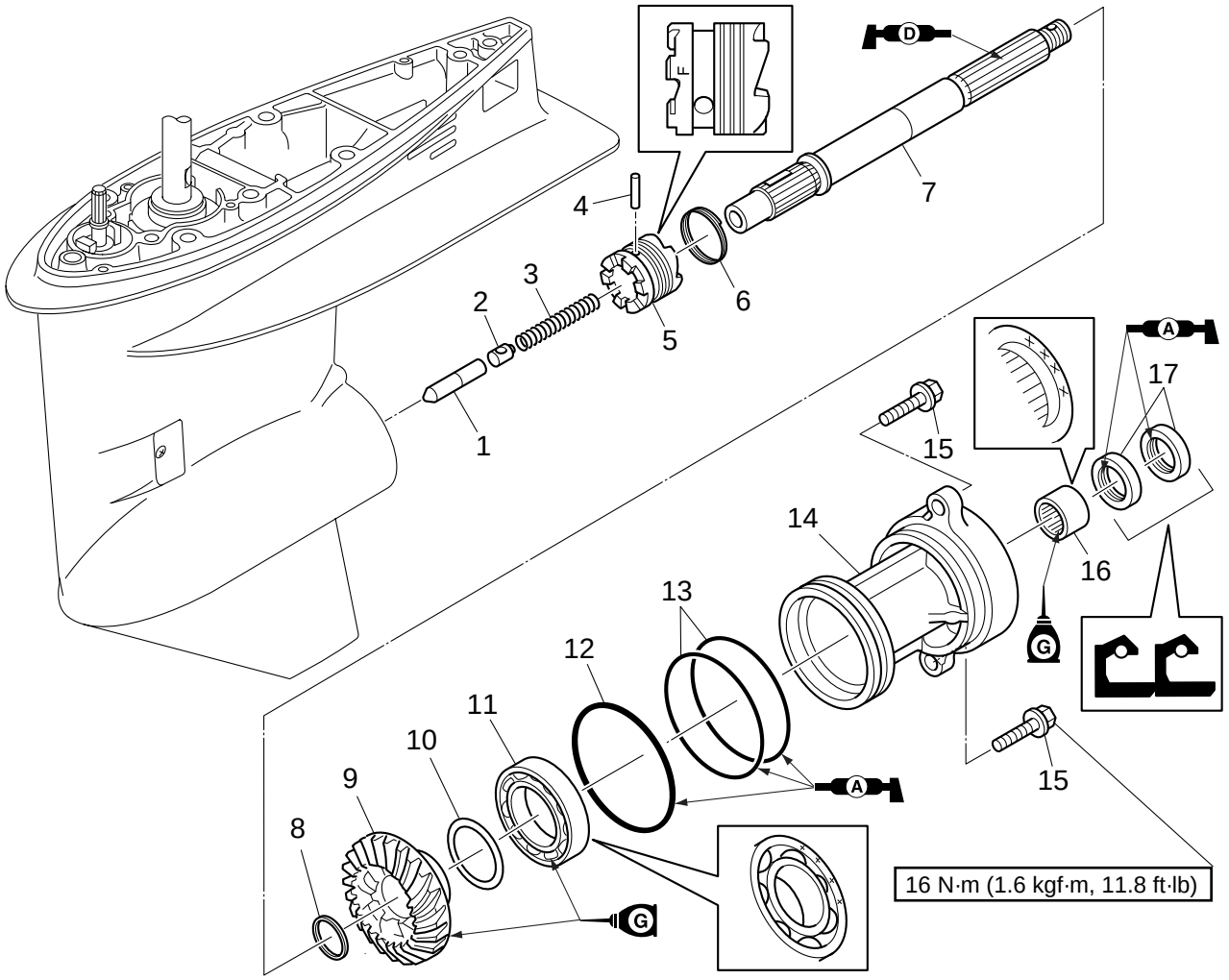
1. Check the water pump housing. Replace if deformed.

TIP:
If the engine overheated, check the water pump housing for deformation.

2. Check the impeller, the insert cartridge, and the outer plate cartridge. Replace if cracked or worn.

3. Check the Woodruff key and the keyway on the drive shaft. Replace if deformed or worn.

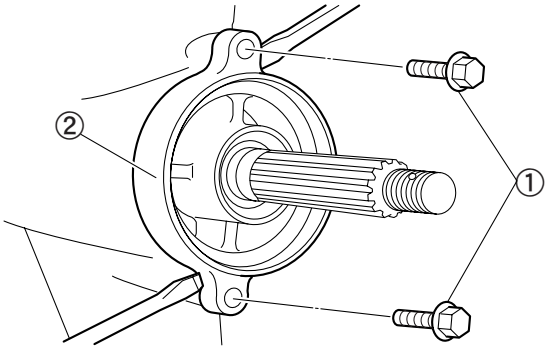
Propeller shaft housing



No.	Part name	Q'ty	Remarks
1	Shift plunger	1	
2	Slider	1	
3	Spring	1	
4	Cross pin	1	
5	Dog clutch	1	
6	Spring	1	
7	Propeller shaft	1	
8	Washer	1	
9	Reverse gear	1	
10	Shim (T2)	—	
11	Ball bearing	1	**Not reusable**
12	O-ring	1	**Not reusable**
13	O-ring	2	**Not reusable**
14	Propeller shaft housing	1	
15	Bolt	2	M8 × 25 mm
16	Needle bearing	1	**Not reusable**
17	Oil seal	2	**Not reusable**

Removing the propeller shaft housing assembly

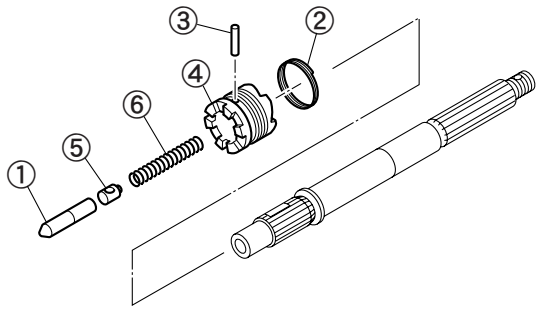
1. Remove the bolts ①, and then remove the propeller shaft housing assembly ②.



TIP:
Insert flat-head screwdrivers between the propeller shaft housing assembly ② and the lower case to pry the assembly loose.

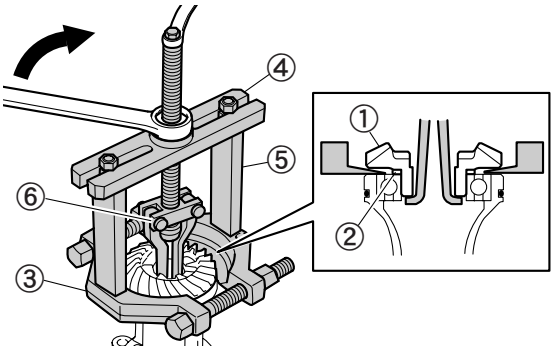
Disassembling the propeller shaft assembly

1. Remove the shift plunger ①.
2. Remove the spring ②, and then remove the cross pin ③ and the dog clutch ④.
3. Remove the slider ⑤ and the spring ⑥.



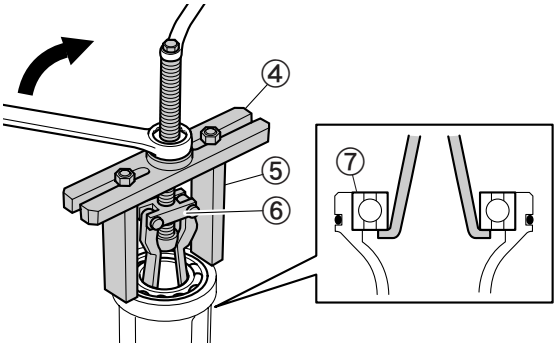
Disassembling the propeller shaft housing assembly

1. Remove the reverse gear ① and the shim(s) (T2) ②.



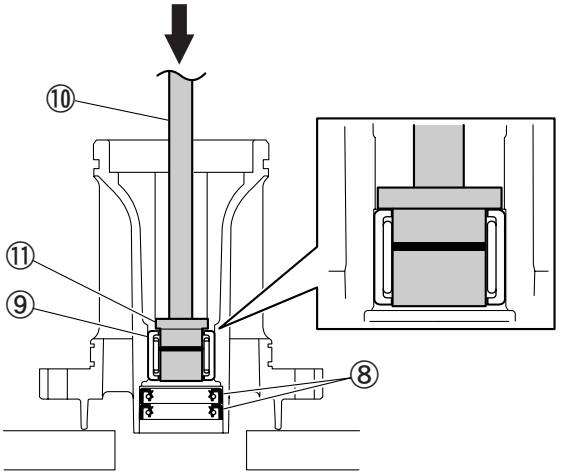
Bearing separator ③: 90890-06534
Stopper guide plate ④: 90890-06501
Stopper guide stand ⑤: 90890-06538
Bearing puller assembly ⑥: 90890-06535

2. Remove the ball bearing ⑦.



Stopper guide plate ④: 90890-06501
Stopper guide stand ⑤: 90890-06538
Bearing puller assembly ⑥: 90890-06535

3. Remove the oil seals ⑧ with the needle bearing ⑨.

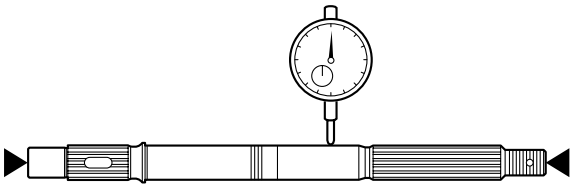


Driver rod L3 ⑩: 90890-06652
Needle bearing attachment ⑪:
90890-06614

Checking the propeller shaft

1. Check the propeller shaft. Replace if damaged or worn.

2. Measure the propeller shaft runout. Replace if above specification.



Propeller shaft runout:
0.02 mm (0.0008 in)

Checking the dog clutch

1. Check the dog clutch, the shift plunger, the slider, the cross pin, and the spring. Replace if cracked or worn.

Checking the propeller shaft housing

1. Check the propeller shaft housing. Replace if cracked or damaged.

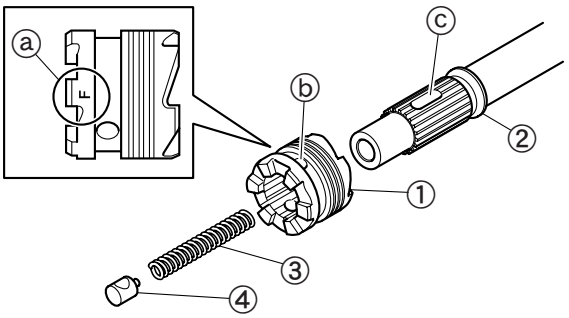
Checking the reverse gear

1. Check the teeth and dogs of the reverse gear. Replace if cracked or worn.

Assembling the propeller shaft assembly

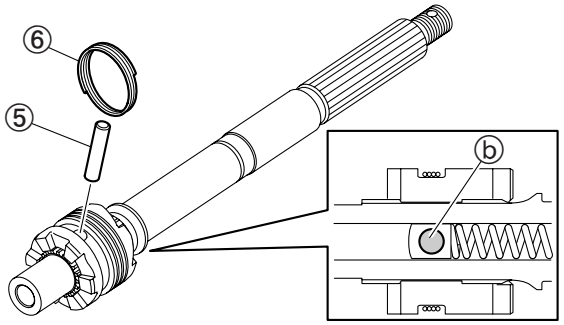
1. Install the dog clutch ① onto the propeller shaft ② with the "F" mark ⓐ facing toward the forward gear.

2. Install the spring ③ and the slider ④ into the propeller shaft ②.



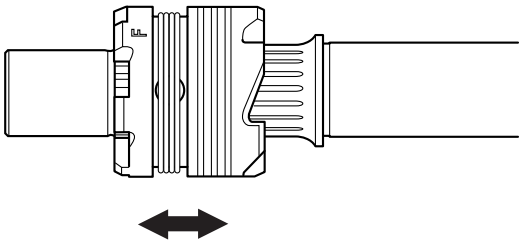
TIP:
Align the hole ⓑ in the dog clutch ① with the hole ⓒ in the propeller shaft ②.

3. Install the cross pin ⑤ and the spring ⑥.



TIP:
When installing the cross pin, align the hole in the dog clutch with the hole ⓑ in the slider.

4. Check that the dog clutch operates smoothly.

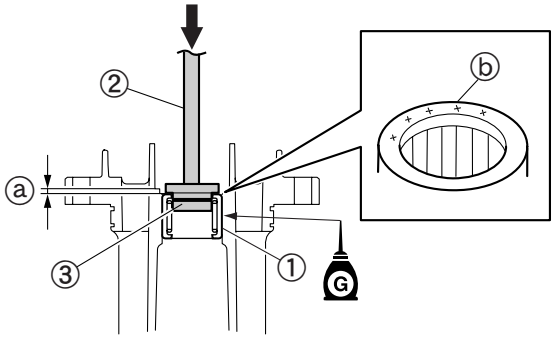


Assembling the propeller shaft housing assembly

NOTICE

Do not reuse the bearing. Always replace it with a new one.

1. Install a new needle bearing ① into the propeller shaft housing to the specified depth.

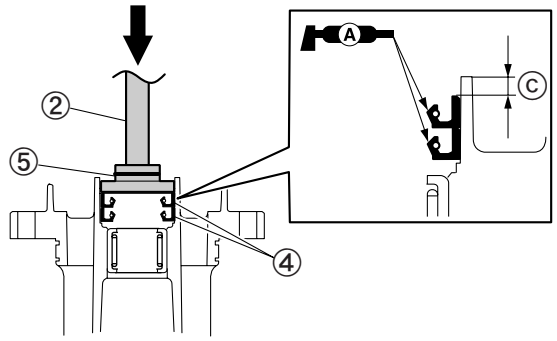


Driver rod L3 ②: 90890-06652
Needle bearing attachment ③:
90890-06614

Installation depth ⓐ:
3.0–3.5 mm (0.118–0.138 in)

TIP:
Install the needle bearing with the manufacture identification mark ⓑ facing toward the propeller side.

2. Install new oil seals ④ into the propeller shaft housing to the specified depth.

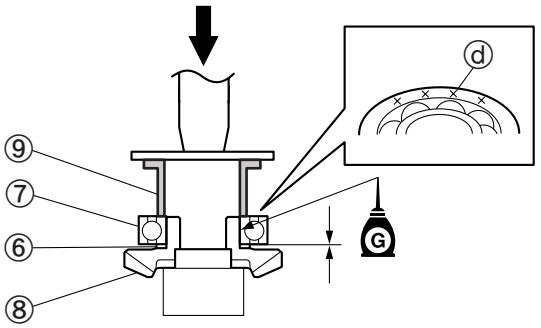


Driver rod L3 ②: 90890-06652
Needle bearing attachment ⑤:
90890-06653

Installation depth ⓒ:
4.0–4.5 mm (0.157–0.177 in)

TIP:
Install an oil seal halfway into the propeller shaft housing, and then install the other oil seal.

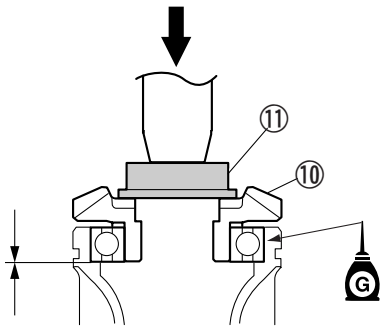
3. Install the original shim(s) (T2) ⑥ and a new ball bearing ⑦ onto the reverse gear ⑧.



Bearing inner race attachment ⑨:
90890-06639

TIP:
Install the ball bearing with the manufacture identification mark ⓓ facing toward the propeller side.

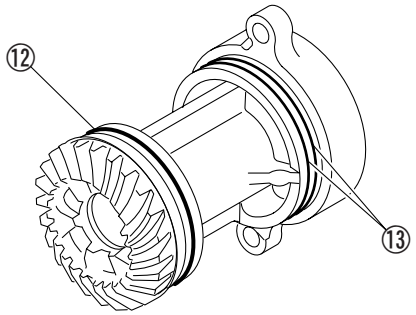
4. Install the reverse gear assembly ⑩ into the propeller shaft housing.



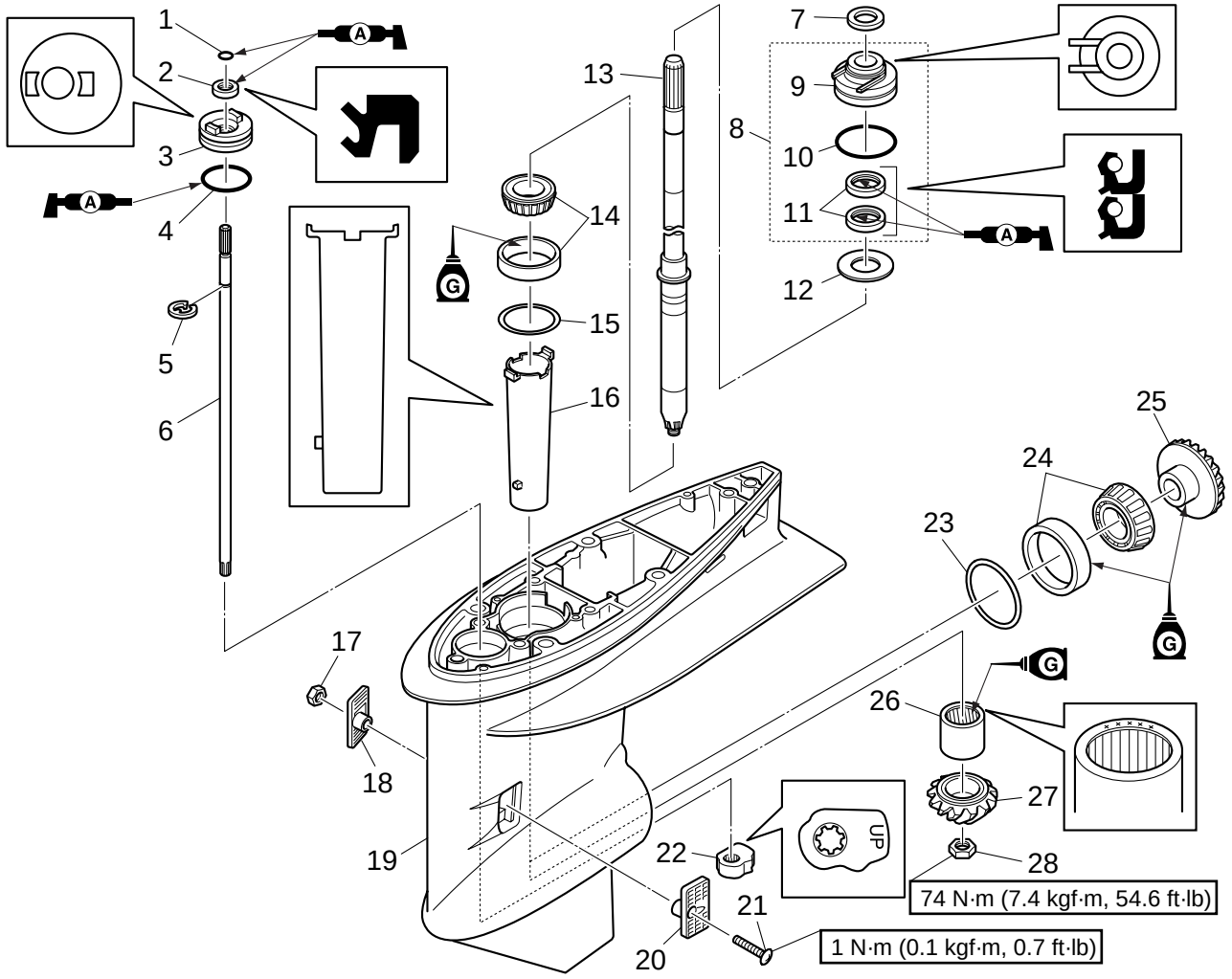
Needle bearing attachment ⑪:
90890-06608

5. After installing the reverse gear assembly, check that the reverse gear rotates smoothly.

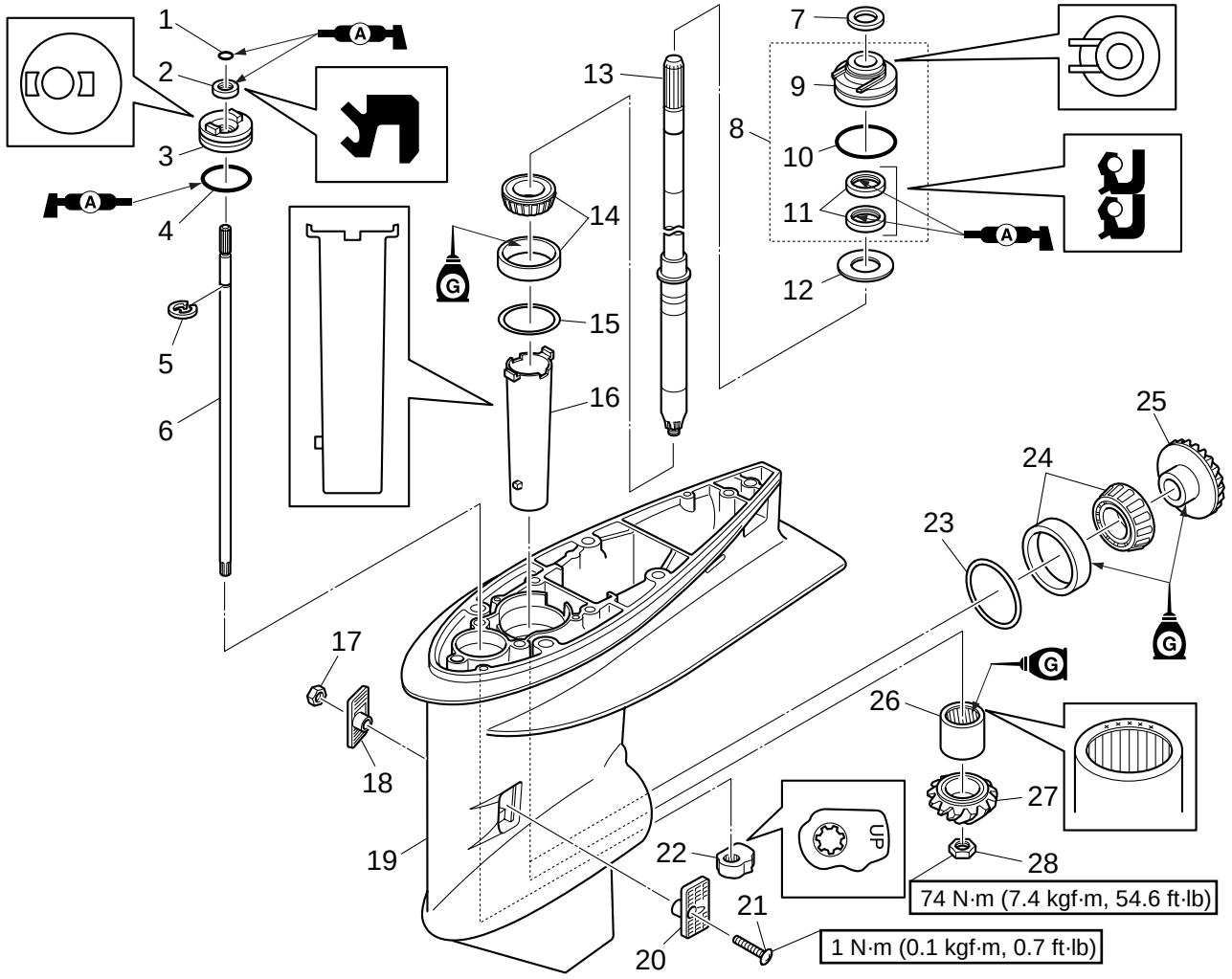
6. Install new O-rings ⑫ and ⑬.



Drive shaft and lower case



No.	Part name	Q'ty	Remarks
1	O-ring	1	**Not reusable**
2	Oil seal	1	**Not reusable**
3	Plate	1	
4	O-ring	1	**Not reusable**
5	E-clip	1	
6	Shift rod	1	
7	Cover	1	
8	Oil seal housing assembly	1	
9	Oil seal housing	1	
10	O-ring	1	**Not reusable**
11	Oil seal	2	**Not reusable**
12	Washer	1	
13	Drive shaft	1	
14	Taper roller bearing	1	**Not reusable**
15	Shim (T3)	—	
16	Sleeve	1	
17	Nut	1	

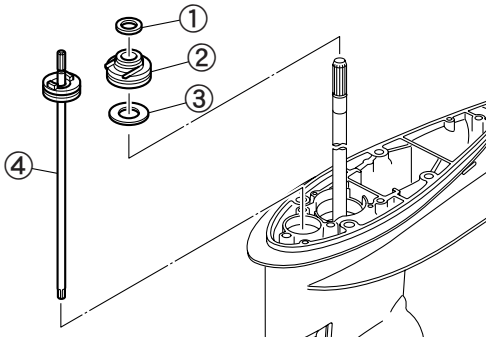


No.	Part name	Q'ty	Remarks
18	Water inlet cover (STBD)	1	
19	Lower case	1	
20	Water inlet cover (PORT)	1	
21	Screw	1	M5 × 25 mm
22	Shift cam	1	
23	Shim (T1)	—	
24	Taper roller bearing	1	**Not reusable**
25	Forward gear	1	
26	Needle bearing	1	**Not reusable**
27	Pinion	1	
28	Nut	1	

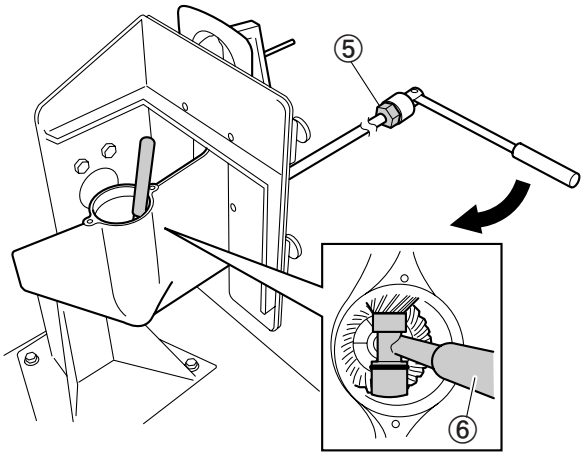
Removing the oil seal housing, drive shaft, and shift rod

1. Remove the cover ①, the oil seal housing assembly ②, and the washer ③.

2. Remove the shift rod assembly ④.



3. Remove the pinion nut, and then remove the drive shaft and the pinion.

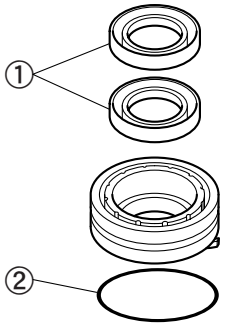


Drive shaft holder 3 ⑤: 90890-06517
Pinion nut holder ⑥: 90890-06715

4. Pull out the forward gear assembly.

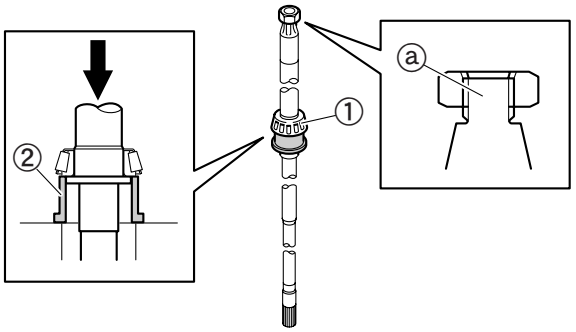
Disassembling the oil seal housing

1. Remove the oil seals ① and the O-ring ②.



Disassembling the drive shaft assembly

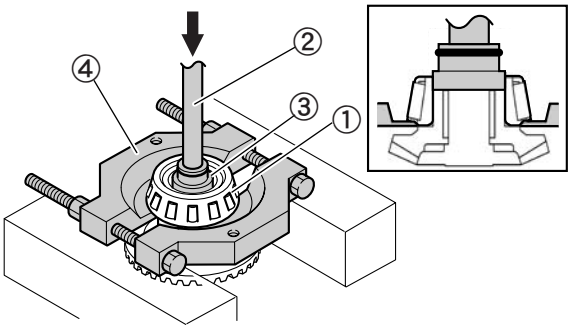
1. Remove the taper roller bearing ①. ***NOTICE:*** **Do not press the drive shaft threads ⓐ directly.**



Bearing inner race attachment ②:
90890-06641

Disassembling the forward gear

1. Remove the taper roller bearing ①.



Driver rod L3 ②: 90890-06652
Needle bearing attachment ③:
90890-06612
Bearing separator ④: 90890-06534

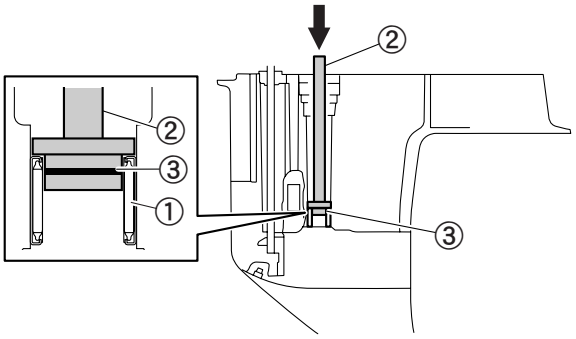
Disassembling the lower case

⚠ WARNING

- **Use heat-resistant gloves. Otherwise, burns could result.**
- **To avoid the risk of fire, remove any flammable substances, such as gasoline and oil, around the working area.**
- **Keep good ventilation while working.**

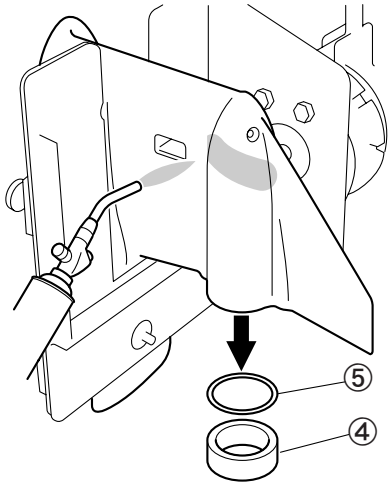
1. Remove the water inlet covers.

2. Remove the needle bearing ①.



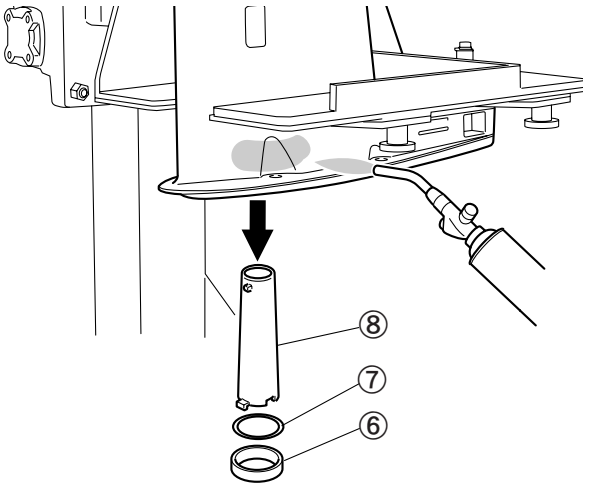
Driver rod L3 ②: 90890-06652
Needle bearing attachment ③:
90890-06614

3. Heat the installation area of the taper roller bearing outer race in the lower case with a gas torch, and then remove the taper roller bearing outer race ④ and shim(s) (T1) ⑤. ***NOTICE:*** **When heating the lower case, heat the entire installation area evenly. Otherwise, the paint on the lower case could be burned.**



TIP:
- Before removing the taper roller bearing outer race ④, place some cushioning material under the lower case to catch the outer race when it falls out.
- If the taper roller bearing outer race does not come out, lightly tap the lower case torpedo with a plastic hammer.

4. Heat the installation area of the taper roller bearing outer race in the lower case with a gas torch, and then remove the taper roller bearing outer race ⑥, the shim(s) (T3) ⑦, and the drive shaft sleeve ⑧. ***NOTICE:*** **When heating the lower case, heat the entire installation area evenly. Otherwise, the paint on the lower case could be burned, or the drive shaft sleeve could be damaged.**



TIP:
- Before removing the taper roller bearing outer race ⑥, place some cushioning material under the lower case to catch the outer race when it falls out.
- If the taper roller bearing outer race does not come out, lightly tap the lower case with a plastic hammer.

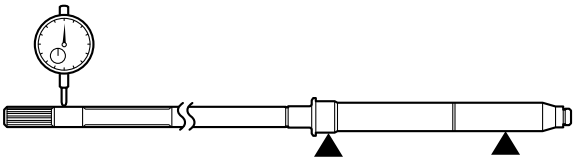
Checking the shift rod
1. Check the shift rod. Replace if bent or worn.

Checking the pinion
1. Check the pinion teeth. Replace if cracked or worn.

Checking the forward gear
1. Check the teeth and dogs of the forward gear. Replace if cracked or worn.

Checking the drive shaft
1. Check the drive shaft. Replace if damaged or worn.

2. Measure the drive shaft runout. Replace if above specification.



Drive shaft runout: 0.5 mm (0.0197 in)

Checking the lower case

1. Check the lower case. Replace if cracked or damaged.

Assembling the lower case

⚠ WARNING

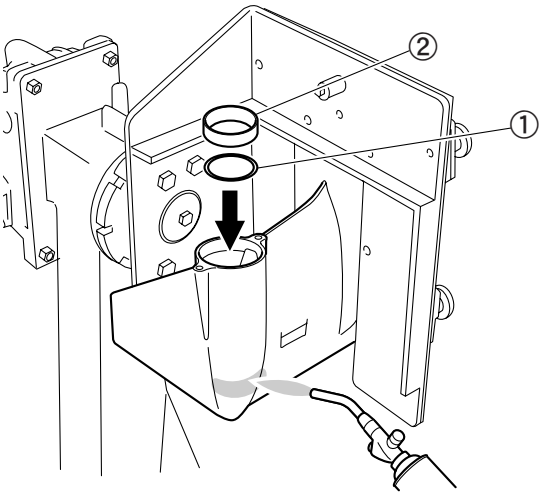
- **Use heat-resistant gloves. Otherwise, burns could result.**
- **To avoid the risk of fire, remove any flammable substances, such as gasoline and oil, around the working area.**
- **Keep good ventilation while working.**

NOTICE

Do not reuse the bearing. Always replace it with a new one.

1. Install the original shim(s) (T1) ①.

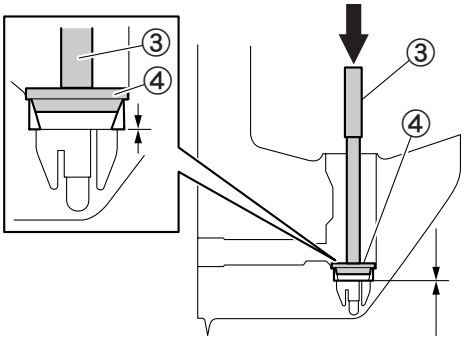
2. Heat the installation area of the taper roller bearing outer race in the lower case with a gas torch, and then install a new taper roller bearing outer race ②. ***NOTICE:*** **When heating the lower case, heat the entire installation area evenly. Otherwise, the paint on the lower case could be burned.**



TIP:

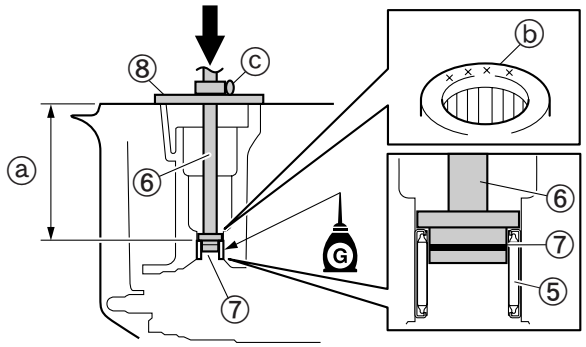
Do not reuse a shim if deformed or scratched.

3. While holding the special service tool ③, strike the tool to check that the taper roller bearing outer race is installed properly. If a high-pitched metallic sound is produced when the special service tool is struck, the outer race is installed properly.



Driver rod LL ③: 90890-06605
Bearing outer race attachment ④: 90890-06622

4. Install a new needle bearing ⑤ into the lower case to the specified depth.

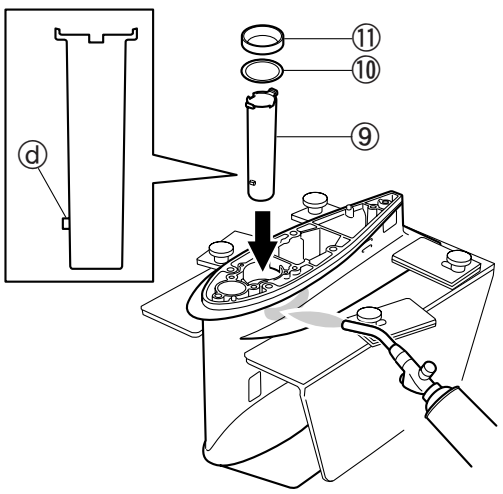


Driver rod SL ⑥: 90890-06602
Needle bearing attachment ⑦:
90890-06614
Bearing depth plate ⑧: 90890-06603

Installation depth ⓐ:
182.5–183.0 mm (7.19–7.20 in)

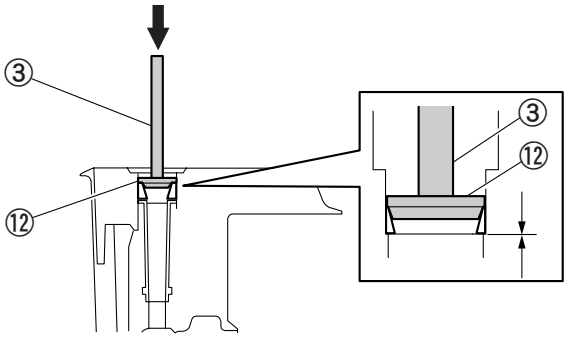
TIP:
- Install a new needle bearing with the identification mark ⓑ facing toward the water pump side.
- When using the driver rod, do not strike the special service tool in a manner that will force the stopper ⓒ out of place.

5. Heat the installation area of the taper roller bearing outer race in the lower case with a gas torch, and then install the drive shaft sleeve ⑨, original shim(s) (T3) ⑩ and a new taper roller bearing outer race ⑪. ***NOTICE:*** **When heating the lower case, heat the entire installation area evenly. Otherwise, the paint on the lower case could be burned.**



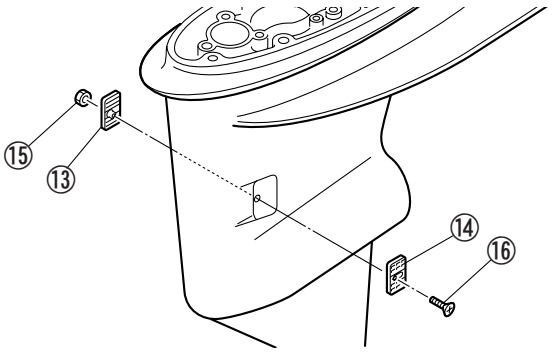
TIP:
- Install the drive shaft sleeve with the protrusion ⓓ facing forward.
- Do not reuse a shim if deformed or scratched.

6. While holding the special service tool ③, strike the tool to check that the taper roller bearing outer race is installed properly. If a high-pitched metallic sound is produced when the special service tool is struck, the outer race is installed properly.



Driver rod LL ③: 90890-06605
Bearing outer race attachment ⑫:
90890-06627

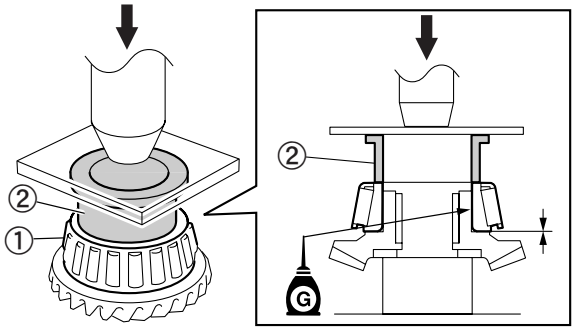
7. Install the water inlet covers ⑬, ⑭, the nut ⑮ and the water inlet cover screw ⑯, and then tighten the water inlet cover screw ⑯ to the specified torque.



Water inlet cover screw ⑯:
1 N·m (0.1 kgf·m, 0.7 ft·lb)

Assembling the forward gear

1. Install a new taper roller bearing ①.



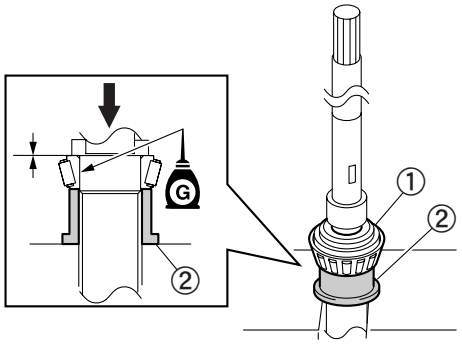
Bearing inner race attachment ②:
90890-06639

Assembling the drive shaft

NOTICE

Do not reuse the bearing. Always replace it with a new one.

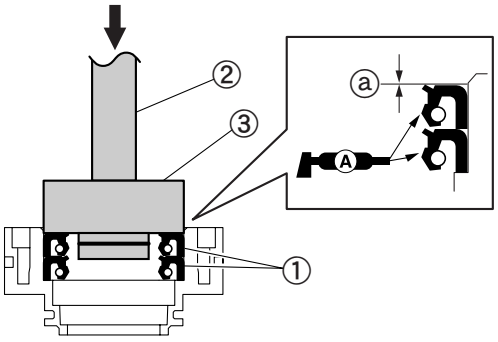
1. Install a new taper roller bearing ①.



Bearing inner race attachment ②:
90890-06644

Assembling the oil seal housing

1. Install new oil seals ① to the specified depth ⓐ.



Driver rod LS ②: 90890-06606
Ball bearing attachment ③: 90890-06634

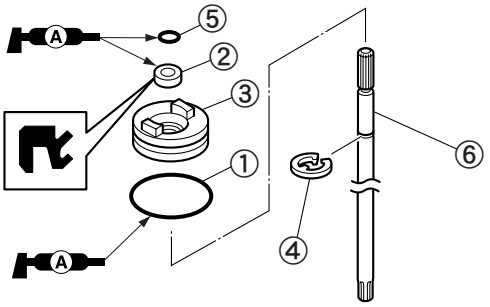
Installation depth ⓐ: 0–0.5 mm (0–0.02 in)

2. Install a new O-ring.

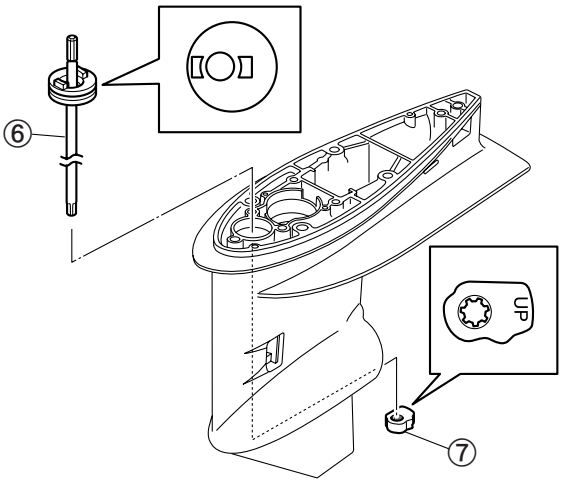
Installing the shift rod, drive shaft, and oil seal housing

1. Install a new O-ring ① and a new oil seal ② to the plate ③.

2. Install the E-clip ④, the plate ③, and a new O-ring ⑤ to the shift rod ⑥.

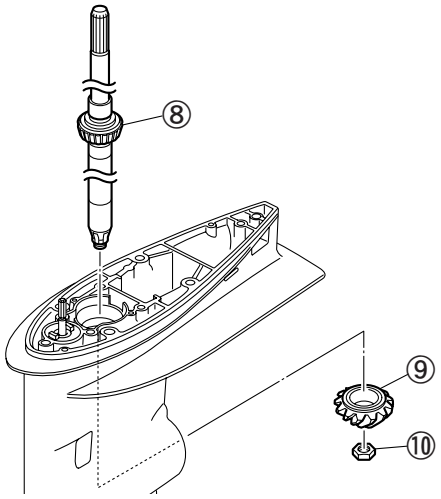


3. Install the shift cam ⑦ and the shift rod ⑥.



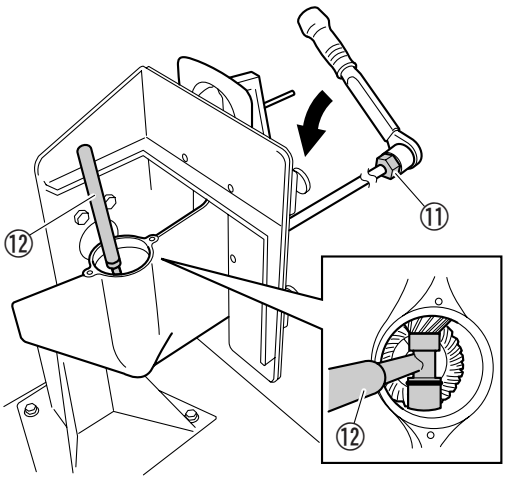
4. Install the forward gear assembly.

5. Install the drive shaft assembly ⑧, the pinion ⑨, and the pinion nut ⑩.



TIP:
When installing the pinion ⑨, lift up the drive shaft ⑧ slightly, and then align the pinion splines with the shaft splines.

6. Tighten the pinion nut to the specified torque.

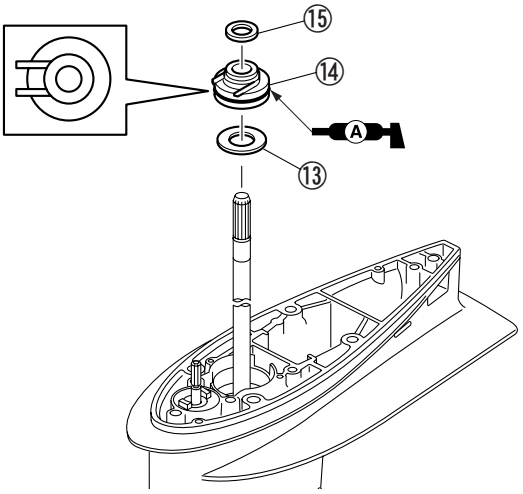


Drive shaft holder 3 ⑪: 90890-06517 Pinion nut holder ⑫: 90890-06715

Pinion nut: 74 N·m (7.4 kgf·m, 54.6 ft·lb)

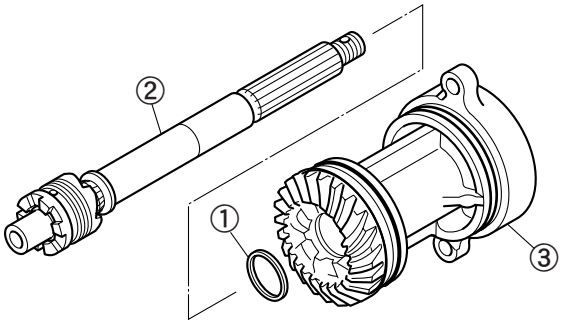
7. Check that the drive shaft rotates smoothly.

8. Install the washer ⑬, the oil seal housing assembly ⑭, and the cover ⑮.

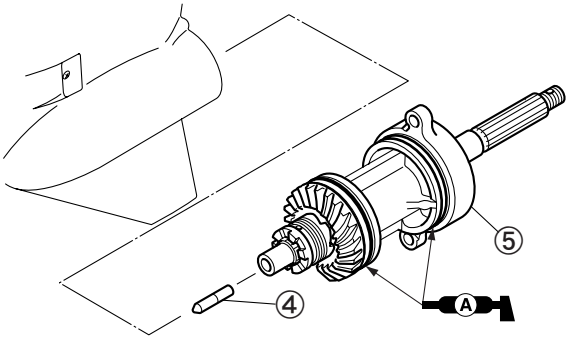


Installing the propeller shaft housing assembly

1. Install the washer ① and the propeller shaft assembly ② into the propeller shaft housing ③.

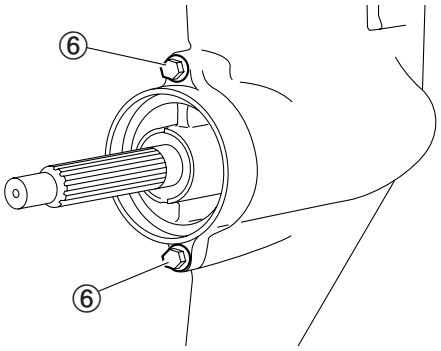


2. Install the shift plunger ④ and the propeller shaft housing assembly ⑤.



3. Tighten the propeller shaft housing bolts ⑥ to the specified torque.

8

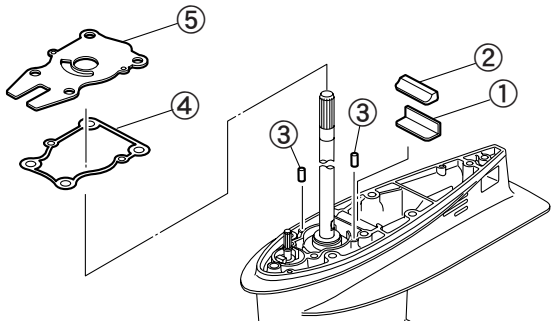


Propeller shaft housing bolt ⑥: 16 N·m (1.6 kgf·m, 11.8 ft·lb)

Installing the water pump

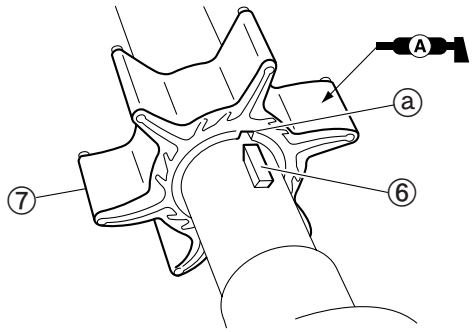
1. Install the plate ① and the rubber seal ②.

2. Install the dowels ③, a new gasket ④, and the outer plate cartridge ⑤.

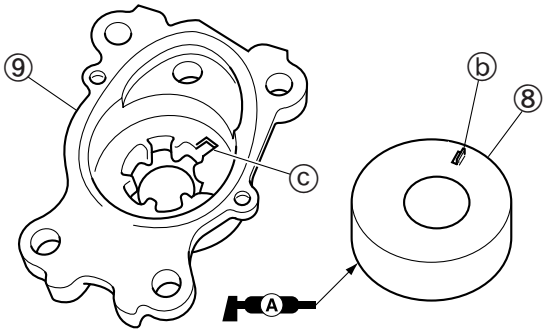


3. Install the Woodruff key ⑥.

4. Align the key way ⓐ on the impeller ⑦ with the Woodruff key ⑥, and then install the impeller ⑦.

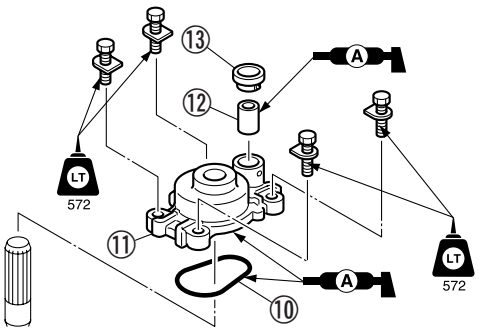


5. Install the insert cartridge ⑧ aligning the protrusion ⓑ on the insert cartridge with the groove ⓒ of the water pump housing ⑨.



6. Install a new O-ring ⑩ and water pump housing assembly ⑪ to the lower unit. ***NOTICE:*** **Do not turn the drive shaft counterclockwise. Otherwise, the water pump impeller may be damaged.**

7. Install the seal ⑫ and the cover ⑬.

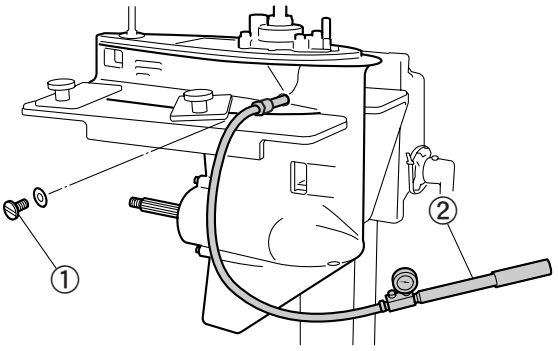


TIP:

When installing the water pump housing, apply grease to the inside of the insert cartridge, and then turn the drive shaft clockwise while pushing down on the water pump housing.

Checking the lower unit for air leakage

1. Remove the gear oil check screw ①, and then install the special service tool ②.



Leakage tester ②: 90890-06840

2. Apply the specified pressure to check that the pressure is maintained in the lower unit for at least 10 seconds. ***NOTICE:*** **Do not over pressurize the lower unit. Otherwise, the oil seals may be damaged.**

Holding pressure:
68.6 kPa (0.686 kgf/cm^2, 9.9 psi)

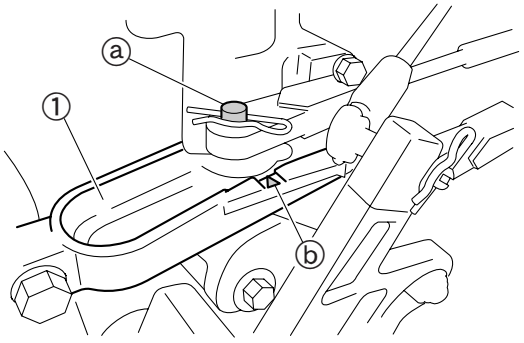
3. If the specified pressure cannot be maintained, check the drive shaft, the propeller shaft and the shift rod oil seals for bends or damage.

Installing the lower unit

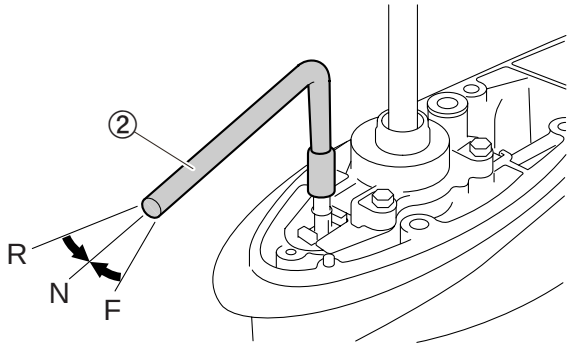
⚠ WARNING

- **Do not hold the propeller with your hands when loosening or tightening it.**
- **Make sure to disconnect the battery cables from the battery and the clip from the engine shut-off switch.**
- **When installing the lower unit with the power unit installed, make sure to suspend the outboard motor. If the outboard motor is not suspended, it can fall suddenly and result in severe injuries.**

1. Check that the pin ⓐ is aligned with the alignment mark ⓑ on the shift bracket ①.



2. Set the gear shift to the N position.



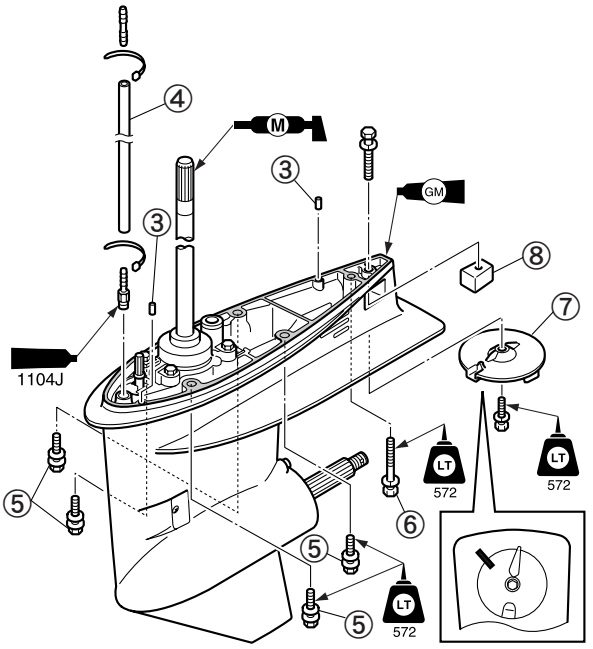
Shift rod push arm ②: 90890-06052

3. Install the dowels ③ and the hose ④ into the lower unit.

4. Install the lower unit to the upper case, and then tighten the lower case mounting bolts ⑤ and ⑥ to the specified torque.

5. Install the trim tab ⑦ to its original position.

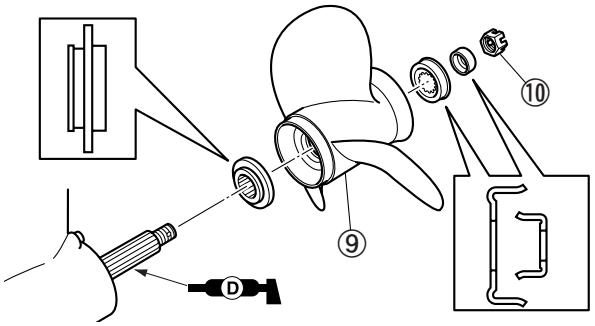
6. Install the anode ⑧.

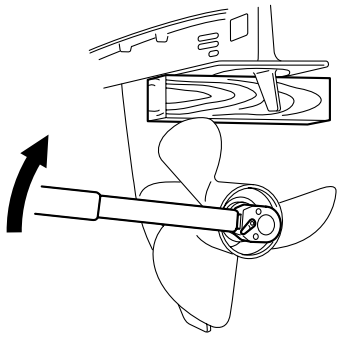


Lower case mounting bolt ⑤ and ⑥:
40 N·m (4.0 kgf·m, 29.5 ft·lb)

8

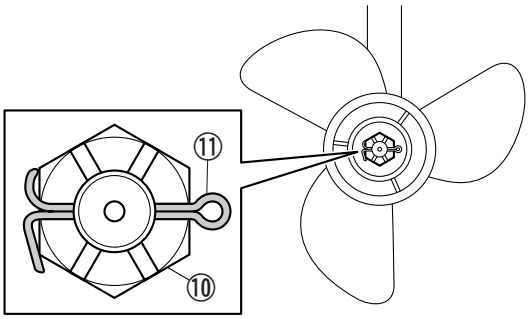
7. Install the propeller ⑨ and the propeller nut ⑩. Place a block of wood between the anti-cavitation plate and the propeller to keep the propeller from turning, and then tighten the propeller nut ⑩ to the specified torque.





Propeller nut ⑩:
35 N·m (3.5 kgf·m, 25.8 ft·lb)

8. Install a new cotter pin ⑪.

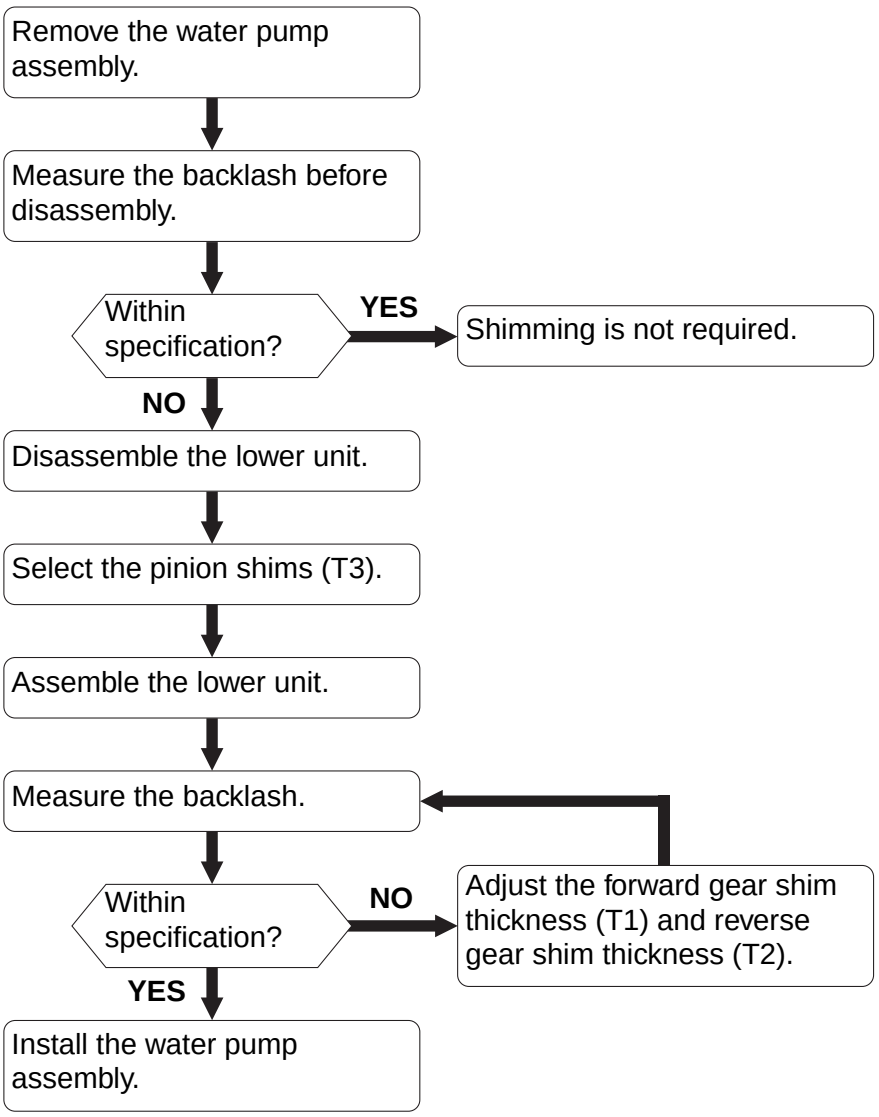


TIP:
If the grooves in the propeller nut ⑩ do not align with the cotter pin hole, tighten the nut until they are aligned.

9. Fill the gear oil to the correct level. See "Changing the gear oil" (10-11) step 5–step 9.

Shimming

Shimming workflow



TIP:

- Shimming is not required if the backlash is within specification.
- Shimming is required when assembling the original inner parts and a new lower case.
- Shimming is required when replacing the pinion, forward gear, reverse gear, bearings, shaft, or the housing.

Shimming check sheet

Lower case deviation

Serial number	P	F	R	Remarks

Pinion height (mm)

	Measurements		
Measurement point #1			
Measurement point #2			
Measurement point #3			
Measurement point #4			
Average			
Truncated average (M)			

Forward gear backlash (mm)

	Measurements					
	Before disassembly			After disassembly		
Measurement point #1						
Measurement point #2						
Measurement point #3						
Measurement point #4						
Average						
Truncated average (BL1)						

Reverse gear backlash (mm)

	Measurements					
	Before disassembly			After disassembly		
Measurement point #1						
Measurement point #2						
Measurement point #3						
Measurement point #4						
Average						
Truncated average (BL2)						

Forward gear shim thickness (T1) measurement in 2 places (mm)

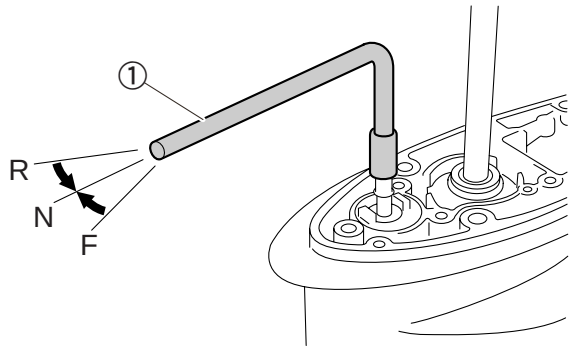
	Number of shim(s)			Subtotal
0.10				
0.12				
0.15				
0.18				
0.30				
0.40				
0.50				
Total				

Reverse gear shim thickness (T2) measurement in 2 places (mm)

	Number of shim(s)			Subtotal
0.10				
0.12				
0.15				
0.18				
0.30				
0.40				
0.50				
Total				

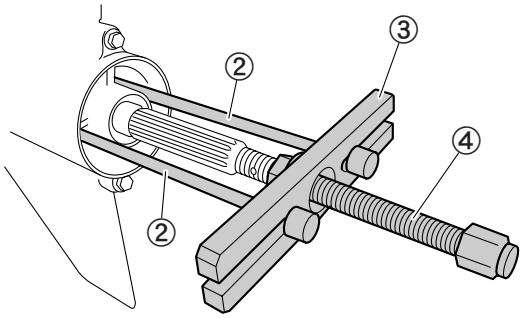
Measuring the forward and reverse gear backlash before disassembly

1. Install the lower unit onto a repair stand.
2. Remove the water pump assembly. See “Removing the water pump” (8-5).
3. Set the gear shift to the N position.



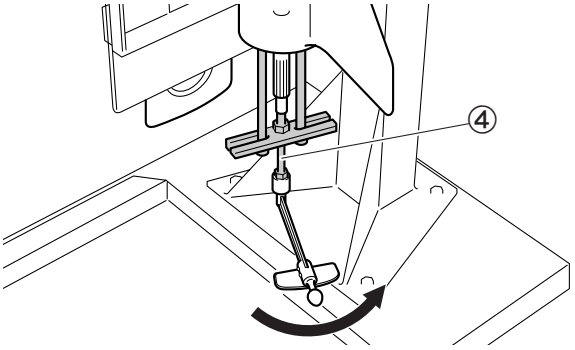
Shift rod push arm ①: 90890-06052

4. Install the special service tools ②, ③, and ④, and then tighten the center bolt ④ temporarily.



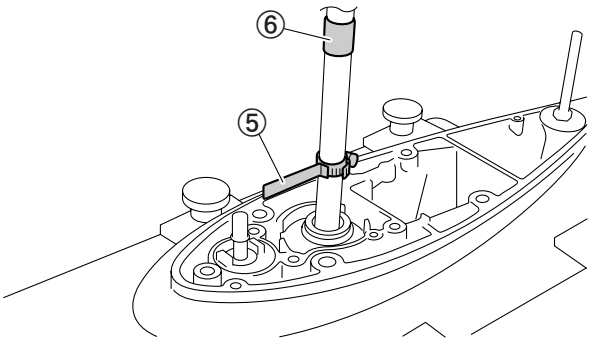
Bearing housing puller claw S ②: 90890-06564
Stopper guide plate ③: 90890-06501
Center bolt ④: 90890-06504

5. Turn the lower unit so that the propeller shaft is pointing downward.
6. Turn the drive shaft 10 times or more to seat the taper roller bearing.
7. Tighten the center bolt ④ to the specified torque while holding the drive shaft to prevent it from turning.



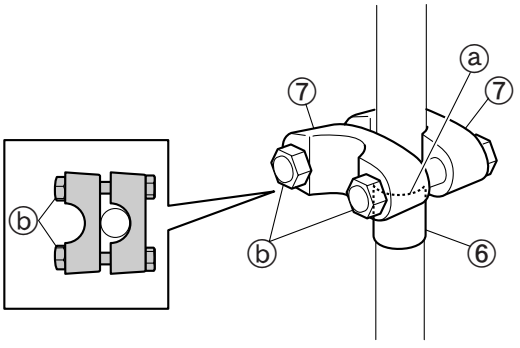
Center bolt ④ (shimming):
5 N·m (0.5 kgf·m,3.7 ft·lb)

8. Turn the lower unit upright.
9. Install the special service tool ⑤ onto the drive shaft at the lowest possible position, the point where the shaft diameter is 16.0 mm (0.63 in).
10. Wrap 5 layers of tape ⑥ around the drive shaft.



Backlash indicator ⑤: 90890-06706

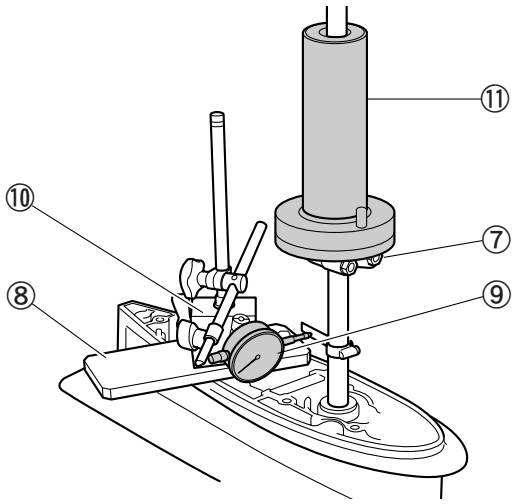
11. Install the handle stopper ⑦ in the upper end ⓐ position of the tape ⑥ on the drive shaft, and then tighten the nuts ⓑ to the specified torque.



Handle stopper ⑦: EU0-23814-30

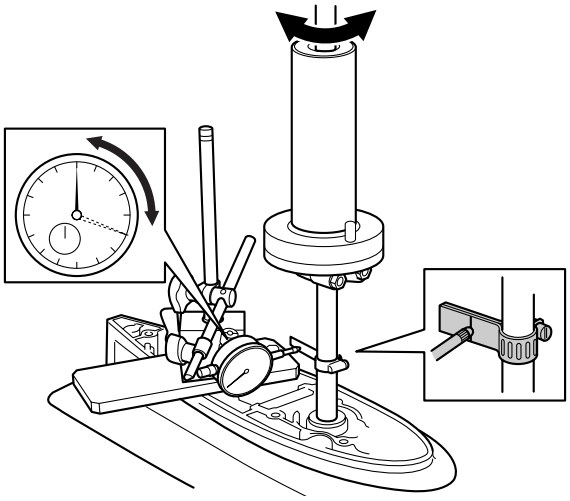
Nut ⓑ (shimming):
2 N·m (0.2 kgf·m, 1.5 ft·lb)

12. Install the special service tools ⑧, ⑨, and ⑩, and then put another special service tool ⑪ on the handle stopper ⑦ to apply a load.



Magnet base plate ⑧: 90890-07003 Dial gauge set ⑨: 90890-01252 Magnet base B ⑩: 90890-06844 Pinion height gauge ⑪: 90890-06668

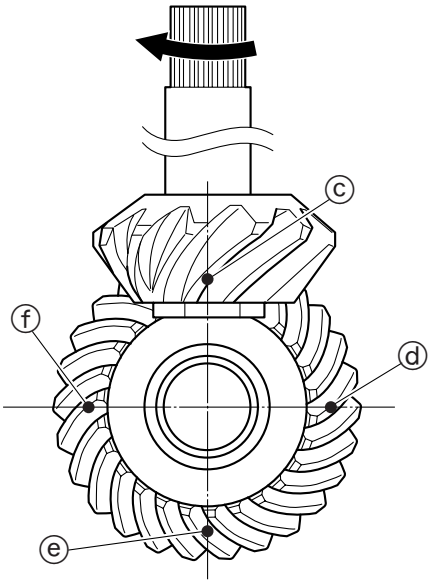
13. Slowly turn the drive shaft clockwise and counterclockwise, and then measure the backlash at the position where it stops in each direction.



TIP:

Do not turn the drive shaft with excessive force. Otherwise, the forward gear will rotate, leading to incorrect measurements.

14. Turn the drive shaft 180° clockwise and measure the backlash again.



TIP:

- Measure the backlash at 4 points: ⓒ, ⓓ, ⓔ, and ⓕ, turning the drive shaft 180° clockwise after each measurement. Note down the measurement data in the shimming check sheet.
- When turning the drive shaft, hold it with a little force. A knocking sound may be heard when the drive shaft is rotated, but this is the sound of the pinion contacting the reverse gear and does not affect the backlash measurement.

15. Determine the backlash average value, and then truncate the number by dropping the figures after the 1/100 place without rounding.

Example:

(mm)

Measurement point ⓒ	0.30
Measurement point ⓓ	0.36
Measurement point ⓔ	0.34
Measurement point ⓕ	0.33
Average	0.3325
Truncated average	0.33

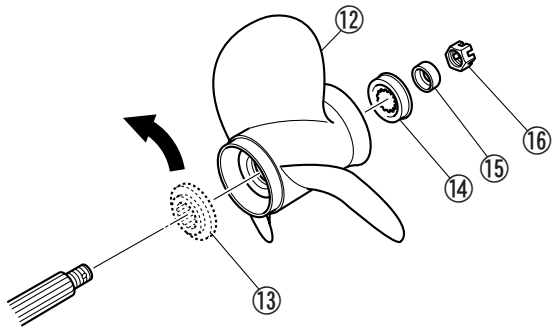
16. Check that the forward gear backlash average is within specification.

Forward gear backlash:
0.18–0.66 mm (0.0071–0.0260 in)

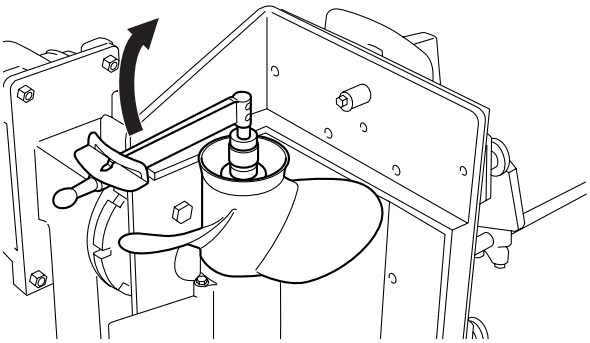
TIP:
Adjust the shim thicknesses if the forward gear backlash is out of specification.

17. Remove the special service tools.

18. Apply a load to the reverse gear by installing the propeller ⑫ (without the spacer ⑬), the washers ⑭, ⑮, and the propeller nut ⑯.



19. Tighten the propeller nut ⑯ to the specified torque.



Propeller nut ⑯ (shimming):
10 N·m (1.0 kgf·m, 7.4 ft·lb)

20. To measure the reverse gear backlash, proceed to the step 8–step 15.

21. Check that the reverse gear backlash average is within specification.

Reverse gear backlash:
0.75–1.23 mm (0.0295–0.0484 in)

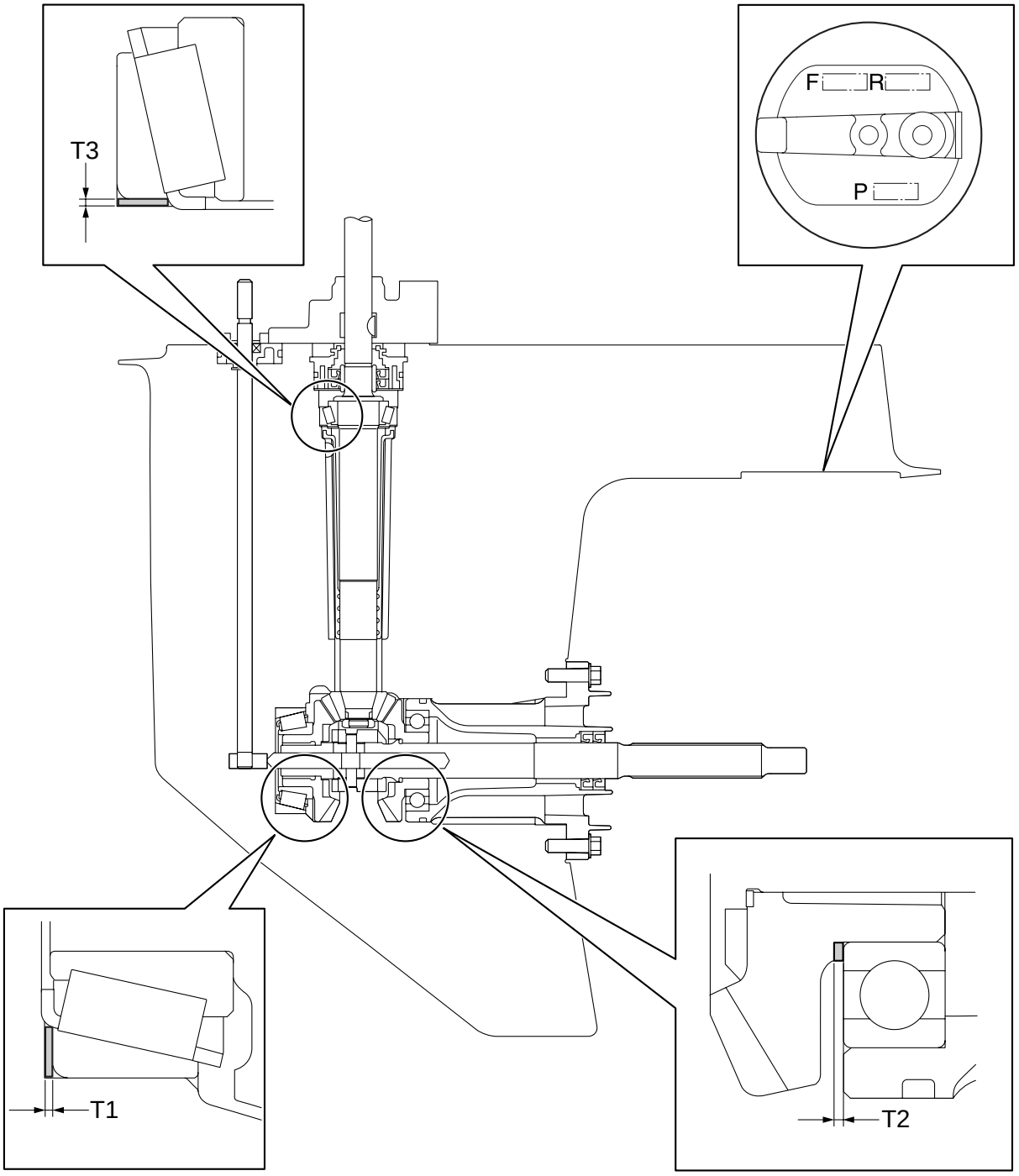
TIP:
Adjust the shim thicknesses if the reverse gear backlash is out of specification.

22. Remove the special service tools, and then install the water pump assembly. See “Installing the water pump” (8-19).

Shimming

- Before selecting the forward gear shim(s) (T1) and reverse gear shim(s) (T2), make sure to select the pinion shim(s) (T3).
- When assembling the lower unit to measure the backlash after selecting the pinion shim(s) (T3), do not apply gear oil, grease, or sealant to the parts.
- When assembling the lower unit after shimming is completed, make sure to apply gear oil, grease, or sealant to the specified areas.

Shim location



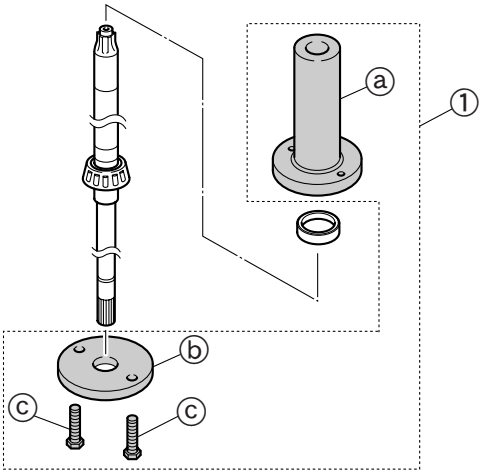
Selecting the pinion shim (T3)

- Spray anti-rust lubricant on the bearing before installation. Do not apply gear oil to the parts. Otherwise, correct measurements cannot be obtained.
- Keep the parts free from foreign materials, such as dirt or lint.

NOTICE

Do not damage the measurement plane surface of the pinion height gauge. Otherwise, accurate measurements cannot be obtained.

1. Install the taper roller bearing and the drive shaft between ⓐ and ⓑ of the special service tool ①, and then tighten the pinion height gauge bolts ⓒ temporarily.



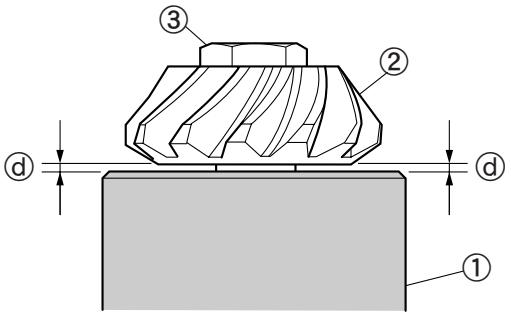
Pinion height gauge set ①: 90890-06668

TIP:

Do not install the shim(s) (T3).

2. Install the pinion ② and the pinion nut ③, and then tighten the pinion nut ③ temporarily.

3. Check the gap ⓓ between the pinion ② and the special service tool ①. ***NOTICE:*** **When tightening the pinion nut ③, check that the drive shaft rotates smoothly. Also, make sure that there is a gap ⓓ between the pinion ② and the special service tool ①. If there is no gap and the drive shaft does not rotate, the special service tool could be damaged.**

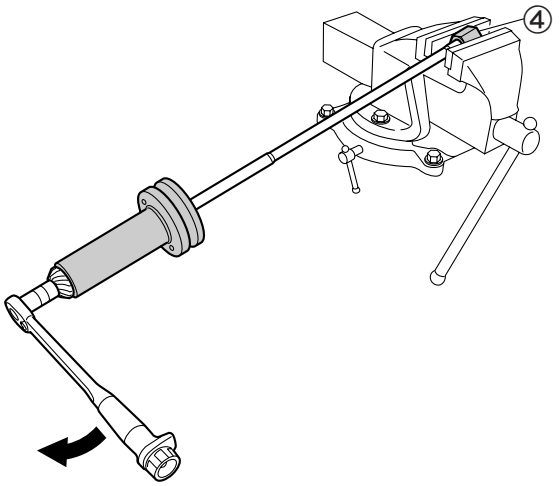


TIP:

If there is no gap, the shim(s) (T3) may not have been removed.

4. Install the special service tool ④ to the drive shaft spline, and hold the special service tool ④.

5. Tighten the pinion nut to the specified torque.



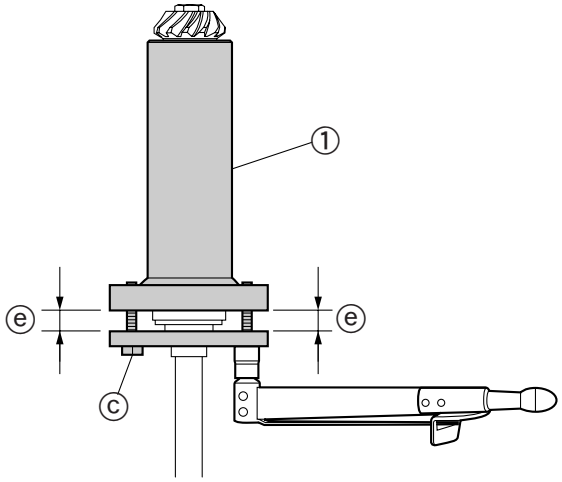
Drive shaft holder 3 ④: 90890-06517

Pinion nut: 74 N·m (7.4 kgf·m, 54.6 ft·lb)

6. Place the pinion facing upward and hold it in the upright position.

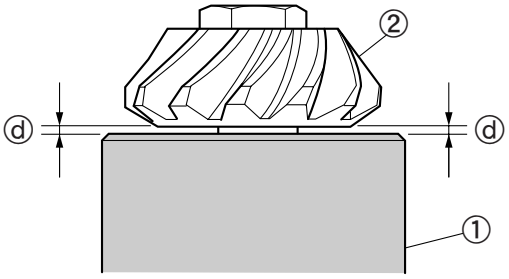
7. Rotate the drive shaft 10 turns or more to seat the taper roller bearing.

8. Tighten the pinion height gauge bolts ⓒ in 4 stages to the specified torque so that the distance ⓔ between the upper part and the lower part of the special service tools ① become equal.



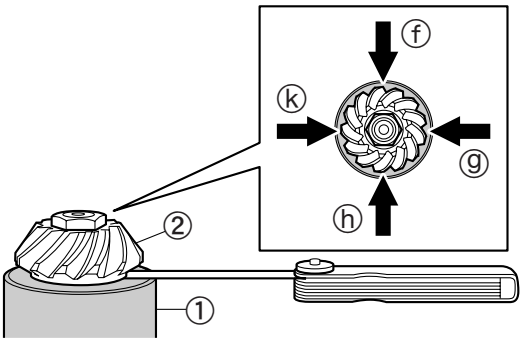
Pinion height gauge bolt ⓒ:
1st: 1 N·m (0.1 kgf·m, 0.7 ft·lb)
2nd: 2 N·m (0.2 kgf·m, 1.5 ft·lb)
3rd: 3 N·m (0.3 kgf·m, 2.2 ft·lb)
4th: 4 N·m (0.4 kgf·m, 3.0 ft·lb)

9. Check again the gap ⓓ between the pinion ② and the special service tool ①.



TIP:
If there is no gap, the shim(s) (T3) may not have been removed.

10. Measure the gap between the pinion ② and the special service tool ①. When measuring the gap, insert the end of the thickness gauge straight into the gap at the measurement point. Do not insert the thickness gauge at an angle.



TIP:
- Measure the gap at the 4 points ⓕ, ⓖ, ⓗ, and ⓚ.
- Note down the measurement data in the shimming check sheet.

11. Determine the gap average value, and then truncate the number by dropping the figures after the 1/100 place without rounding.

Example:

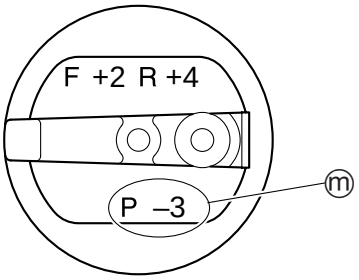
(mm)

Measurement point ⓕ	0.20
Measurement point ⓖ	0.20
Measurement point ⓗ	0.19
Measurement point ⓚ	0.18
Average	0.1925
Truncated average (M)	0.19

12. Determine the pinion shim thickness (T3) in the “Pinion shim (T3) selection tables” according to the truncated average (M) and the deviation (P) stamped on the lower case.

Available shim thicknesses:
0.10, 0.12, 0.15, 0.18, 0.30, 0.40, and 0.50 mm

Example:
(M) = 0.19
(P) = –3



(T3) = 0.60 mm from the “pinion shim (T3) selection table.”

		Pinion height measurement (M)		
		0.18	0.19	0.20
Stamped value on the lower case (P)	–2		↓	
	–3	→	0.60	
	–4			

TIP:
The (P) mark ⓜ is stamped on the trim tab mounting surface of the lower case in 0.01 mm units. If the (P) mark is unreadable, replace the lower case.

13. Remove the special service tools, and then install the determined shim(s) (T3).

Pinion shim (T3) selection table

(mm)

P/M		A											
		0.05	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.15	0.16
B	13	0.30	0.32	0.32	0.35	0.35	0.35	0.38	0.38	0.38	0.40	0.40	0.42
	12	0.32	0.32	0.35	0.35	0.35	0.38	0.38	0.38	0.40	0.40	0.42	0.42
	11	0.32	0.35	0.35	0.35	0.38	0.38	0.38	0.40	0.40	0.42	0.42	0.45
	10	0.35	0.35	0.35	0.38	0.38	0.38	0.40	0.40	0.42	0.42	0.45	0.45
	9	0.35	0.35	0.38	0.38	0.38	0.40	0.40	0.42	0.42	0.45	0.45	0.45
	8	0.35	0.38	0.38	0.38	0.40	0.40	0.42	0.42	0.45	0.45	0.45	0.48
	7	0.38	0.38	0.38	0.40	0.40	0.42	0.42	0.45	0.45	0.45	0.48	0.48
	6	0.38	0.38	0.40	0.40	0.42	0.42	0.45	0.45	0.45	0.48	0.48	0.48
	5	0.38	0.40	0.40	0.42	0.42	0.45	0.45	0.45	0.48	0.48	0.48	0.50
	4	0.40	0.40	0.42	0.42	0.45	0.45	0.45	0.48	0.48	0.48	0.50	0.50
	3	0.40	0.42	0.42	0.45	0.45	0.45	0.48	0.48	0.48	0.50	0.50	0.52
	2	0.42	0.42	0.45	0.45	0.45	0.48	0.48	0.48	0.50	0.50	0.52	0.52
	1	0.42	0.45	0.45	0.45	0.48	0.48	0.48	0.50	0.50	0.52	0.52	0.55
B	0	0.45	0.45	0.45	0.48	0.48	0.48	0.50	0.50	0.52	0.52	0.55	0.55
	–1	0.45	0.45	0.48	0.48	0.48	0.50	0.50	0.52	0.52	0.55	0.55	0.55
	–2	0.45	0.48	0.48	0.48	0.50	0.50	0.52	0.52	0.55	0.55	0.55	0.58
	–3	0.48	0.48	0.48	0.50	0.50	0.52	0.52	0.55	0.55	0.55	0.58	0.58
	–4	0.48	0.48	0.50	0.50	0.52	0.52	0.55	0.55	0.55	0.58	0.58	0.58
	–5	0.48	0.50	0.50	0.52	0.52	0.55	0.55	0.55	0.58	0.58	0.58	0.60
	–6	0.50	0.50	0.52	0.52	0.55	0.55	0.55	0.58	0.58	0.58	0.60	0.60
	–7	0.50	0.52	0.52	0.55	0.55	0.55	0.58	0.58	0.58	0.60	0.60	0.62
	–8	0.52	0.52	0.55	0.55	0.55	0.58	0.58	0.58	0.60	0.60	0.62	0.62
	–9	0.52	0.55	0.55	0.55	0.58	0.58	0.58	0.60	0.60	0.62	0.62	0.65
	–10	0.55	0.55	0.55	0.58	0.58	0.58	0.60	0.60	0.62	0.62	0.65	0.65
	–11	0.55	0.55	0.58	0.58	0.58	0.60	0.60	0.62	0.62	0.65	0.65	0.65
	–12	0.55	0.58	0.58	0.58	0.60	0.60	0.62	0.62	0.65	0.65	0.65	0.68
	–13	0.58	0.58	0.58	0.60	0.60	0.62	0.62	0.65	0.65	0.65	0.68	0.68

P/M		A											
		0.17	0.18	0.19	0.20	0.21	0.22	0.23	0.24	0.25	0.26	0.27	0.28
B	13	0.42	0.45	0.45	0.45	0.48	0.48	0.48	0.50	0.50	0.52	0.52	0.55
	12	0.45	0.45	0.45	0.48	0.48	0.48	0.50	0.50	0.52	0.52	0.55	0.55
	11	0.45	0.45	0.48	0.48	0.48	0.50	0.50	0.52	0.52	0.55	0.55	0.55
	10	0.45	0.48	0.48	0.48	0.50	0.50	0.52	0.52	0.55	0.55	0.55	0.58
	9	0.48	0.48	0.48	0.50	0.50	0.52	0.52	0.55	0.55	0.55	0.58	0.58
	8	0.48	0.48	0.50	0.50	0.52	0.52	0.55	0.55	0.55	0.58	0.58	0.58
	7	0.48	0.50	0.50	0.52	0.52	0.55	0.55	0.55	0.58	0.58	0.58	0.60
	6	0.50	0.50	0.52	0.52	0.55	0.55	0.55	0.58	0.58	0.58	0.60	0.60
	5	0.50	0.52	0.52	0.55	0.55	0.55	0.58	0.58	0.58	0.60	0.60	0.62
	4	0.52	0.52	0.55	0.55	0.55	0.58	0.58	0.58	0.60	0.60	0.62	0.62
	3	0.52	0.55	0.55	0.55	0.58	0.58	0.58	0.60	0.60	0.62	0.62	0.65
	2	0.55	0.55	0.55	0.58	0.58	0.58	0.60	0.60	0.62	0.62	0.65	0.65
	1	0.55	0.55	0.58	0.58	0.58	0.60	0.60	0.62	0.62	0.65	0.65	0.65
B	0	0.55	0.58	0.58	0.58	0.60	0.60	0.62	0.62	0.65	0.65	0.65	0.68
	–1	0.58	0.58	0.58	0.60	0.60	0.62	0.62	0.65	0.65	0.65	0.68	0.68
	–2	0.58	0.58	0.60	0.60	0.62	0.62	0.65	0.65	0.65	0.68	0.68	0.68
	–3	0.58	0.60	0.60	0.62	0.62	0.65	0.65	0.65	0.68	0.68	0.68	0.70
	–4	0.60	0.60	0.62	0.62	0.65	0.65	0.65	0.68	0.68	0.68	0.70	0.70
	–5	0.60	0.62	0.62	0.65	0.65	0.65	0.68	0.68	0.68	0.70	0.70	0.72
	–6	0.62	0.62	0.65	0.65	0.65	0.68	0.68	0.68	0.70	0.70	0.72	0.72
	–7	0.62	0.65	0.65	0.65	0.68	0.68	0.68	0.70	0.70	0.72	0.72	0.75
	–8	0.65	0.65	0.65	0.68	0.68	0.68	0.70	0.70	0.72	0.72	0.75	0.75
	–9	0.65	0.65	0.68	0.68	0.68	0.70	0.70	0.72	0.72	0.75	0.75	0.75
	–10	0.65	0.68	0.68	0.68	0.70	0.70	0.72	0.72	0.75	0.75	0.75	0.78
	–11	0.68	0.68	0.68	0.70	0.70	0.72	0.72	0.75	0.75	0.75	0.78	0.78
	–12	0.68	0.68	0.70	0.70	0.72	0.72	0.75	0.75	0.75	0.78	0.78	0.78
	–13	0.68	0.70	0.70	0.72	0.72	0.75	0.75	0.75	0.78	0.78	0.78	0.80

A Pinion height measurement (M)
B Value stamped on the lower case (P)

(mm)

P/M		A											
		0.29	0.30	0.31	0.32	0.33	0.34	0.35	0.36	0.37	0.38	0.39	0.40
	13	0.55	0.55	0.58	0.58	0.58	0.60	0.60	0.62	0.62	0.65	0.65	0.65
	12	0.55	0.58	0.58	0.58	0.60	0.60	0.62	0.62	0.65	0.65	0.65	0.68
	11	0.58	0.58	0.58	0.60	0.60	0.62	0.62	0.65	0.65	0.65	0.68	0.68
	10	0.58	0.58	0.60	0.60	0.62	0.62	0.65	0.65	0.65	0.68	0.68	0.68
	9	0.58	0.60	0.60	0.62	0.62	0.65	0.65	0.65	0.68	0.68	0.68	0.70
	8	0.60	0.60	0.62	0.62	0.65	0.65	0.65	0.68	0.68	0.68	0.70	0.70
	7	0.60	0.62	0.62	0.65	0.65	0.65	0.68	0.68	0.68	0.70	0.70	0.72
	6	0.62	0.62	0.65	0.65	0.65	0.68	0.68	0.68	0.70	0.70	0.72	0.72
	5	0.62	0.65	0.65	0.65	0.68	0.68	0.68	0.70	0.70	0.72	0.72	0.75
	4	0.65	0.65	0.65	0.68	0.68	0.68	0.70	0.70	0.72	0.72	0.75	0.75
	3	0.65	0.65	0.68	0.68	0.68	0.70	0.70	0.72	0.72	0.75	0.75	0.75
	2	0.65	0.68	0.68	0.68	0.70	0.70	0.72	0.72	0.75	0.75	0.75	0.78
	1	0.68	0.68	0.68	0.70	0.70	0.72	0.72	0.75	0.75	0.75	0.78	0.78
B	0	0.68	0.68	0.70	0.70	0.72	0.72	0.75	0.75	0.75	0.78	0.78	0.78
	–1	0.68	0.70	0.70	0.72	0.72	0.75	0.75	0.75	0.78	0.78	0.78	0.80
	–2	0.70	0.70	0.72	0.72	0.75	0.75	0.75	0.78	0.78	0.78	0.80	0.80
	–3	0.70	0.72	0.72	0.75	0.75	0.75	0.78	0.78	0.78	0.80	0.80	0.82
	–4	0.72	0.72	0.75	0.75	0.75	0.78	0.78	0.78	0.80	0.80	0.82	0.82
	–5	0.72	0.75	0.75	0.75	0.78	0.78	0.78	0.80	0.80	0.82	0.82	0.85
	–6	0.75	0.75	0.75	0.78	0.78	0.78	0.80	0.80	0.82	0.82	0.85	0.85
	–7	0.75	0.75	0.78	0.78	0.78	0.80	0.80	0.82	0.82	0.85	0.85	0.85
	–8	0.75	0.78	0.78	0.78	0.80	0.80	0.82	0.82	0.85	0.85	0.85	0.88
	–9	0.78	0.78	0.78	0.80	0.80	0.82	0.82	0.85	0.85	0.85	0.88	0.88
	–10	0.78	0.78	0.80	0.80	0.82	0.82	0.85	0.85	0.85	0.88	0.88	0.88
	–11	0.78	0.80	0.80	0.82	0.82	0.85	0.85	0.85	0.88	0.88	0.88	0.90
	–12	0.80	0.80	0.82	0.82	0.85	0.85	0.85	0.88	0.88	0.88	0.90	0.90
	–13	0.80	0.82	0.82	0.85	0.85	0.85	0.88	0.88	0.88	0.90	0.90	0.92

P/M		A							
		0.41	0.42	0.43	0.44	0.45	0.46	0.47	0.48
	13	0.68	0.68	0.68	0.70	0.70	0.72	0.72	0.75
	12	0.68	0.68	0.70	0.70	0.72	0.72	0.75	0.75
	11	0.68	0.70	0.70	0.72	0.72	0.75	0.75	0.75
	10	0.70	0.70	0.72	0.72	0.75	0.75	0.75	0.78
	9	0.70	0.72	0.72	0.75	0.75	0.75	0.78	0.78
	8	0.72	0.72	0.75	0.75	0.75	0.78	0.78	0.78
	7	0.72	0.75	0.75	0.75	0.78	0.78	0.78	0.80
	6	0.75	0.75	0.75	0.78	0.78	0.78	0.80	0.80
	5	0.75	0.75	0.78	0.78	0.78	0.80	0.80	0.82
	4	0.75	0.78	0.78	0.78	0.80	0.80	0.82	0.82
	3	0.78	0.78	0.78	0.80	0.80	0.82	0.82	0.85
	2	0.78	0.78	0.80	0.80	0.82	0.82	0.85	0.85
	1	0.78	0.80	0.80	0.82	0.82	0.85	0.85	0.85
B	0	0.80	0.80	0.82	0.82	0.85	0.85	0.85	0.88
	–1	0.80	0.82	0.82	0.85	0.85	0.85	0.88	0.88
	–2	0.82	0.82	0.85	0.85	0.85	0.88	0.88	0.88
	–3	0.82	0.85	0.85	0.85	0.88	0.88	0.88	0.90
	–4	0.85	0.85	0.85	0.88	0.88	0.88	0.90	0.90
	–5	0.85	0.85	0.88	0.88	0.88	0.90	0.90	0.92
	–6	0.85	0.88	0.88	0.88	0.90	0.90	0.92	0.92
	–7	0.88	0.88	0.88	0.90	0.90	0.92	0.92	0.95
	–8	0.88	0.88	0.90	0.90	0.92	0.92	0.95	0.95
	–9	0.88	0.90	0.90	0.92	0.92	0.95	0.95	0.95
	–10	0.90	0.90	0.92	0.92	0.95	0.95	0.95	0.98
	–11	0.90	0.92	0.92	0.95	0.95	0.95	0.98	0.98
	–12	0.92	0.92	0.95	0.95	0.95	0.98	0.98	0.98
	–13	0.92	0.95	0.95	0.95	0.98	0.98	0.98	1.00

A Pinion height measurement (M)
B Value stamped on the lower case (P)

Measuring the forward gear backlash

- Spray anti-rust lubricant on the gear and bearings before installation. Do not apply gear oil to the parts. Otherwise, correct measurements cannot be obtained.
- Keep the parts free from foreign materials, such as dirt or lint.
- When measuring the forward or the reverse gear backlash, use the original bearings and shims.

⚠ WARNING

- **Use heat-resistant gloves. Otherwise, burns could result.**
- **To avoid the risk of fire, remove any flammable substances, such as gasoline and oil, around the working area.**
- **Keep good ventilation while working.**

1. Install the original shim(s) (T1).

TIP:

- If the original shim(s) (T1) are missing, install new shims with a combined thickness of 0.50 mm.
- Do not reuse a shim if deformed or scratched.

2. Install the taper roller bearing outer race. See “Assembling the lower case” (8-15) step 2 and step 3.

3. Install the forward gear assembly, the drive shaft, the pinion, and the pinion nut. See “Installing the shift rod, drive shaft, and oil seal housing” (8-17) step 4–step 7.

4. Check that the drive shaft rotates smoothly.

5. Install the propeller shaft housing assembly. See “Installing the propeller shaft housing assembly” (8-18).

6. Check that the drive shaft rotates smoothly.

7. Measure the forward gear backlash. See “Measuring the forward and reverse gear backlash before disassembly” (8-25) step 3–step 16.

Forward gear backlash:
0.18–0.66 mm (0.0071–0.0260 in)

Adjusting the forward gear shim thickness (T1)

1. Remove the taper roller bearing outer race. See “Disassembling the lower case” (8-13) step 3.

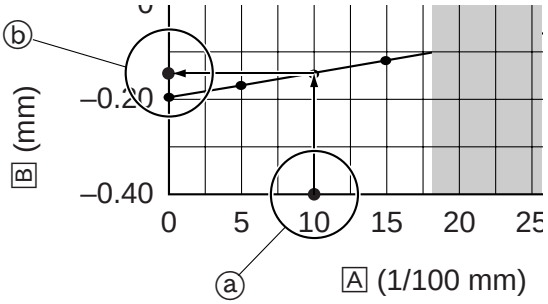
2. Measure the thickness of each original shim(s) (T1) in 2 places.

TIP:

Do not reuse a shim if deformed or scratched.

3. Determine the forward gear shim thickness (T1) adjustment using the “Forward gear shim (T1) selection chart” according to the truncated average (BL1) from “Measuring the forward gear backlash.”

Example:
(BL1) = 0.10 mm ⓐ
(T1) adjustment = –0.15 mm ⓑ from the “Forward gear shim (T1) selection chart.”
The current shim thickness must be decreased by 0.15 mm.



A	0	5	10	15	20	25
B	–0.20	–0.17	–0.15	–0.12		

A Backlash measurement (BL1)
B Shim thickness adjustment

8

TIP:

- If the shim thickness adjustment value is positive, the current shim thickness must be increased by that amount and, if the value is negative, the current shim thickness must be decreased by that amount.
- The gray-colored area on the selection chart indicates the range of the specified backlash. Shimming is not required if the measured backlash is within the gray-colored area.
- The values for the shim thickness adjustments specified in the selection chart are intended to achieve the median value within the range for the specified forward or reverse gear backlash.
- The table below the selection chart shows the shim thickness adjustments for the points marked on the chart.

4. Calculate the new forward gear shim thickness (T1) in the same way as in the example.

Calculation formula:
New forward gear shim thickness (T1) = Current forward gear shim thickness + Shim thickness adjustment
Example:
If the current forward gear shim thickness is 0.50 and the shim thickness adjustment is –0.20 mm, then
(T1) = 0.50 mm + (–0.20) mm
= 0.50 mm – 0.20 mm
= 0.30 mm

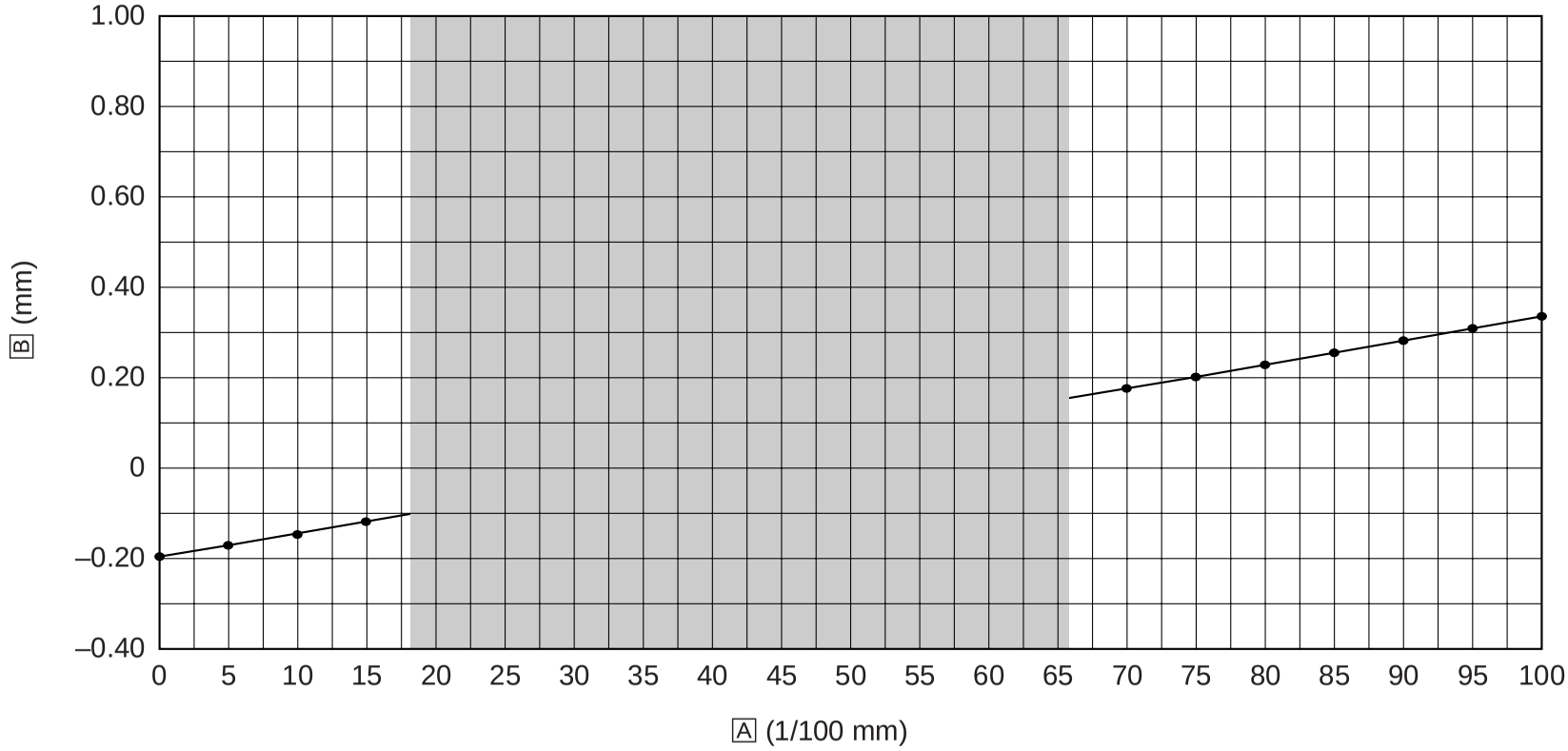
Available shim thicknesses:
0.10, 0.12, 0.15, 0.18, 0.30, 0.40, and 0.50 mm

TIP:

- Use the lowest number of shims to achieve the required shim thickness.
- If the calculated shim thickness cannot be obtained with a combination of the available shims, increase or decrease the shim thickness by 0.01 mm.

5. Install the shim(s) (T1) and the taper roller bearing outer race.

Forward gear shim (T1) selection chart



A	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
B	–0.20	–0.17	–0.15	–0.12											0.17	0.20	0.23	0.25	0.28	0.31	0.33

A Backlash measurement (BL1)
B Increasing or decreasing of shim thickness

Measuring the reverse gear backlash

- Spray anti-rust lubricant on the gear and bearings before installation. Do not apply gear oil to the parts. Otherwise, correct measurements cannot be obtained.
- Keep the parts free from foreign materials, such as dirt or lint.
- When measuring the forward or the reverse gear backlash, use the original bearing and shims.

1. Install the ball bearing and the original shim(s) (T2) onto the reverse gear, and then install the reverse gear assembly into the propeller shaft housing. See "Assembling the propeller shaft housing assembly" (8-8) step 3–step 5.

TIP:

- If the original shim(s) are missing, install new shim(s) (T2) with a combined thickness of 0.50 mm.
- Do not reuse a shim if deformed or scratched.

2. Install the propeller shaft housing assembly into the lower case. See "Installing the propeller shaft housing assembly" (8-18).

3. Check that the drive shaft rotates smoothly.

4. Measure the reverse gear backlash. See "Measuring the forward and reverse gear backlash before disassembly" (8-25) step 18–step 21.

Reverse gear backlash:
0.75–1.23 mm (0.0295–0.0484 in)

Adjusting the reverse gear shim thickness (T2)

1. Remove the reverse gear and the shim(s) (T2). See "Disassembling the propeller shaft housing assembly" (8-7) step 1.

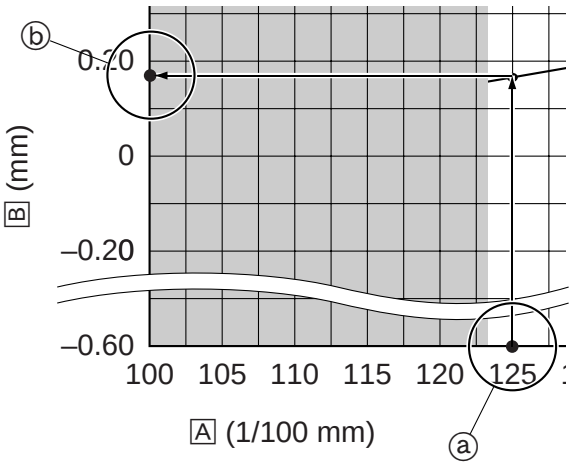
2. Measure the thickness of each original shim(s) (T2) in 2 places.

TIP:

Do not reuse a shim if deformed or scratched.

3. Determine the reverse gear shim thickness (T2) adjustment using the "Reverse gear shim (T2) selection chart" according to the truncated average (BL2) from "Measuring the reverse gear backlash."

Example:
(BL2) = 1.25 mm ⓐ
(T2) adjustment = 0.16 mm ⓑ from the "Reverse gear shim (T2) selection chart."
The current shim thickness must be increased by 0.16 mm.



A	100	105	110	115	120	125	
B						0.16	

A Backlash measurement (BL2)
B Shim thickness adjustment

TIP:

- If the shim thickness adjustment value is positive, the current shim thickness must be increased by that amount and, if the value is negative, the current shim thickness must be decreased by that amount.
- The gray-colored area on the selection chart indicates the range of the specified backlash. Shimming is not required if the measured backlash is within the gray-colored area.

- The values for the shim thickness adjustments specified in the selection chart are intended to achieve the median value within the range for the specified forward or reverse gear backlash.
- The table below the selection chart shows the shim thickness adjustments for the points marked on the chart.

4. Calculate the new reverse gear shim thickness (T2) in the same way as in the example.

Calculation formula:
New reverse gear shim thickness (T2) = Current reverse gear shim thickness + Shim thickness adjustment
Example:
If the current reverse gear shim thickness is 0.62 mm and the shim thickness adjustment is –0.22 mm, then
(T2) = 0.62 mm + (–0.22) mm
= 0.62 mm – 0.22 mm
= 0.40 mm

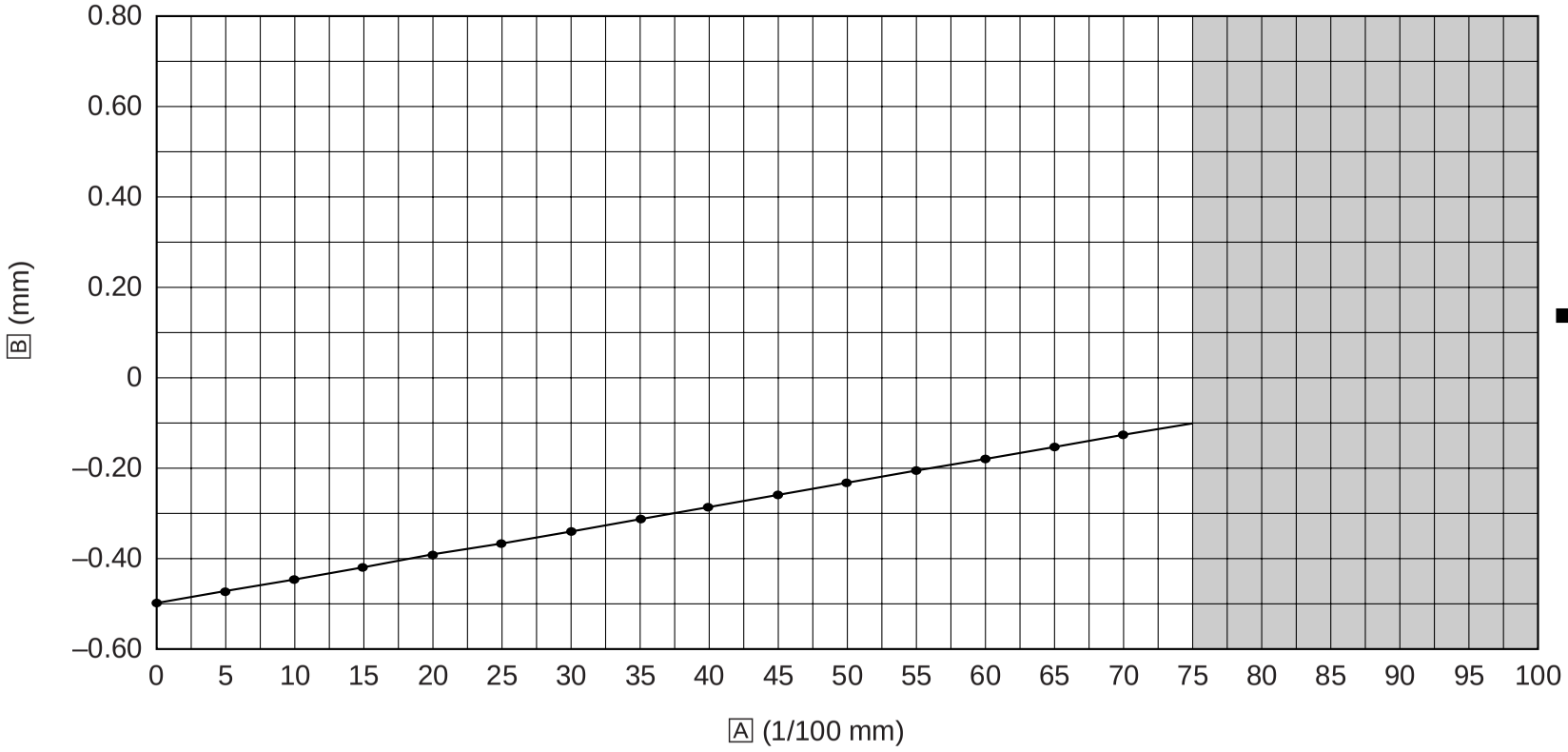
Available shim thicknesses:
0.10, 0.12, 0.15, 0.18, 0.30, 0.40, and 0.50 mm

TIP:

- Use the lowest number of shims to achieve the required shim thickness.
- If the calculated shim thickness cannot be obtained with a combination of the available shims, increase or decrease the shim thickness by 0.01 mm.

5. Install the shim(s) (T2) and propeller shaft housing assembly.

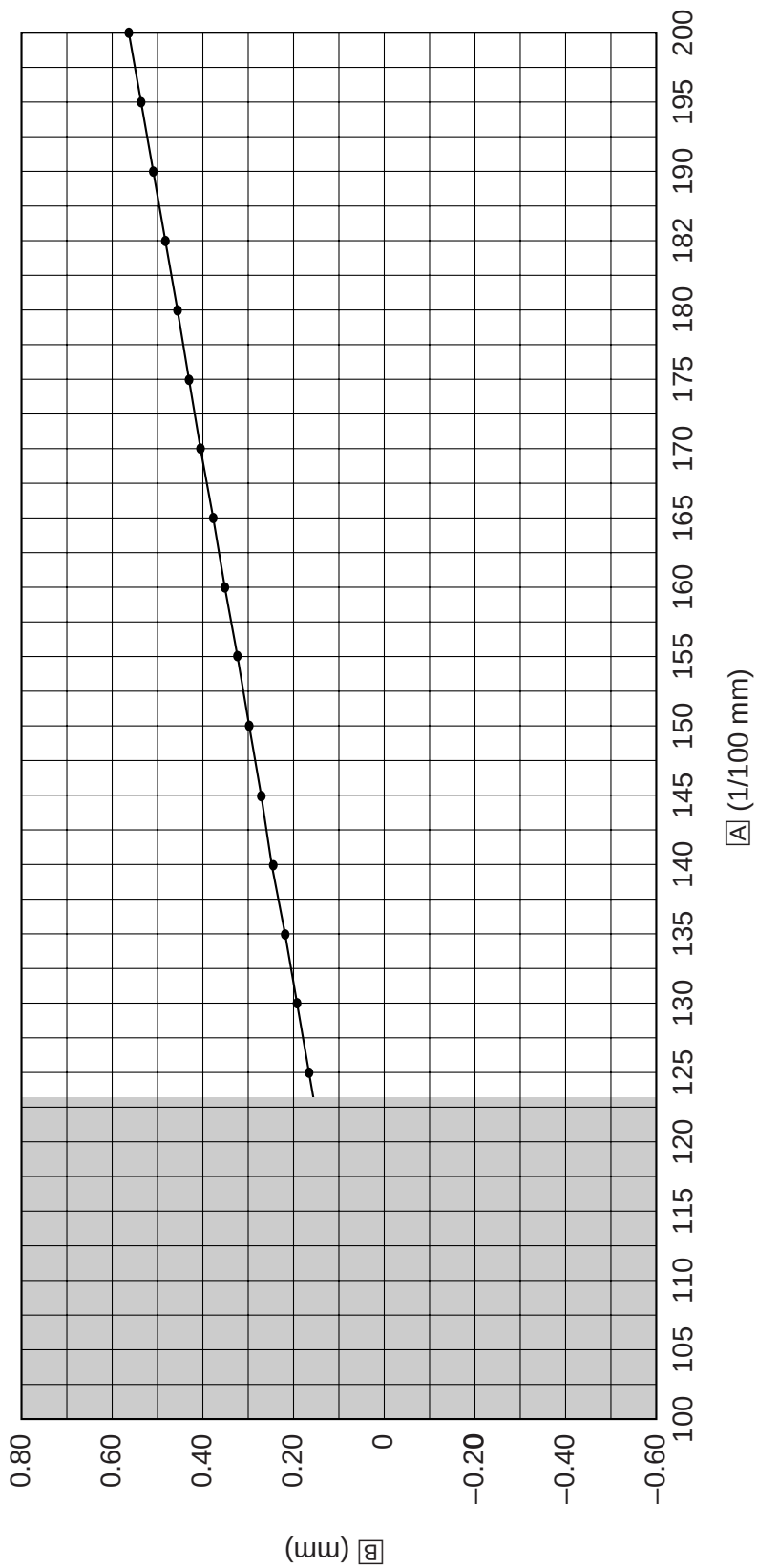
Reverse gear shim (T2) selection chart



Continue next page

A	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
B	–0.50	–0.47	–0.45	–0.42	–0.39	–0.37	–0.34	–0.31	–0.29	–0.26	–0.23	–0.21	–0.18	–0.15	–0.13						

A Backlash measurement (BL2)
B Increasing or decreasing of shim thickness



A	100	105	110	115	120	125	130	135	140	145	150	155	160	165	170	175	180	182	190	195	200
B						0.16	0.19	0.22	0.24	0.27	0.30	0.32	0.35	0.38	0.40	0.43	0.46	0.48	0.51	0.54	0.56

A Backlash measurement (BL2)
B Increasing or decreasing of shim thickness

Bracket unit

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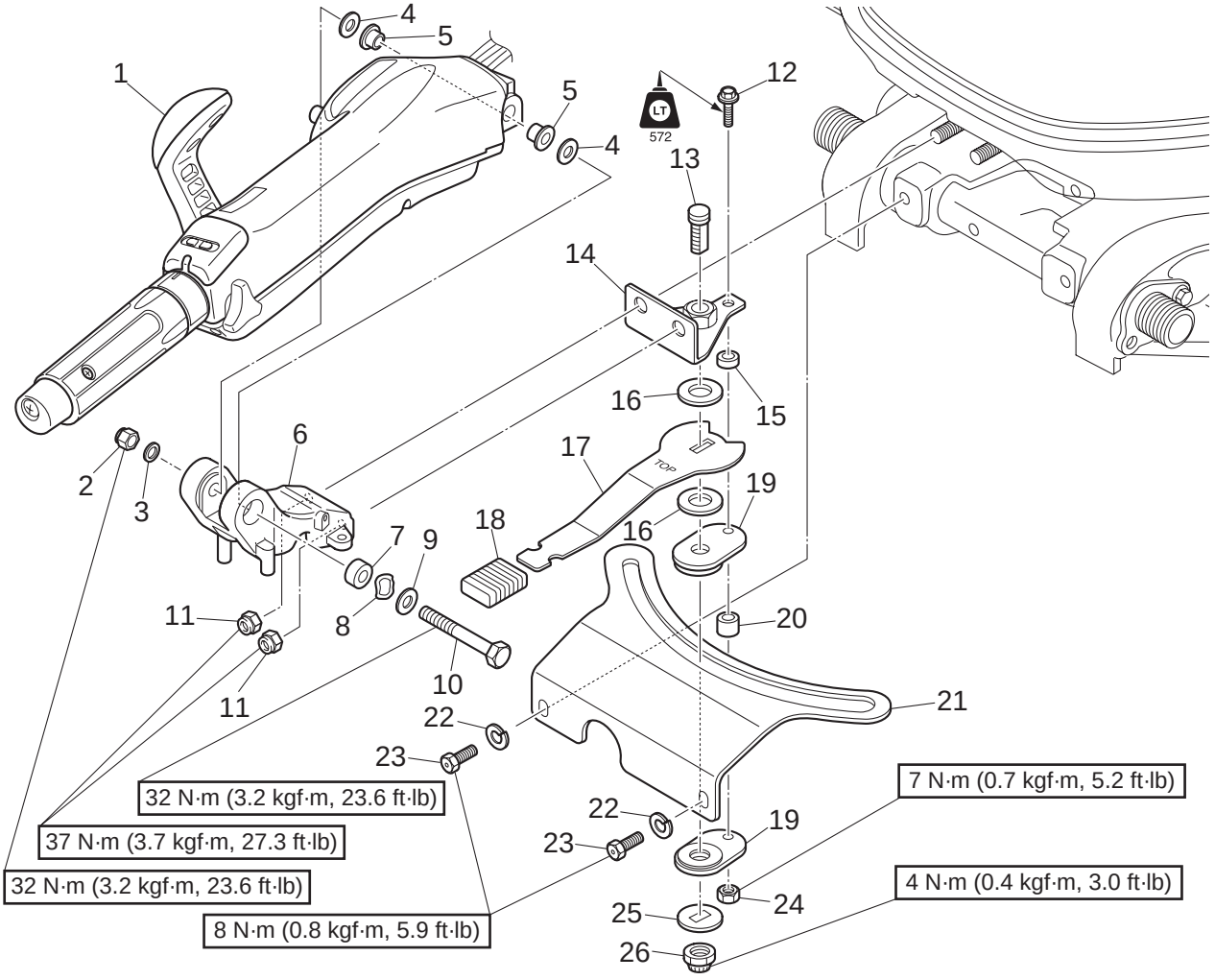
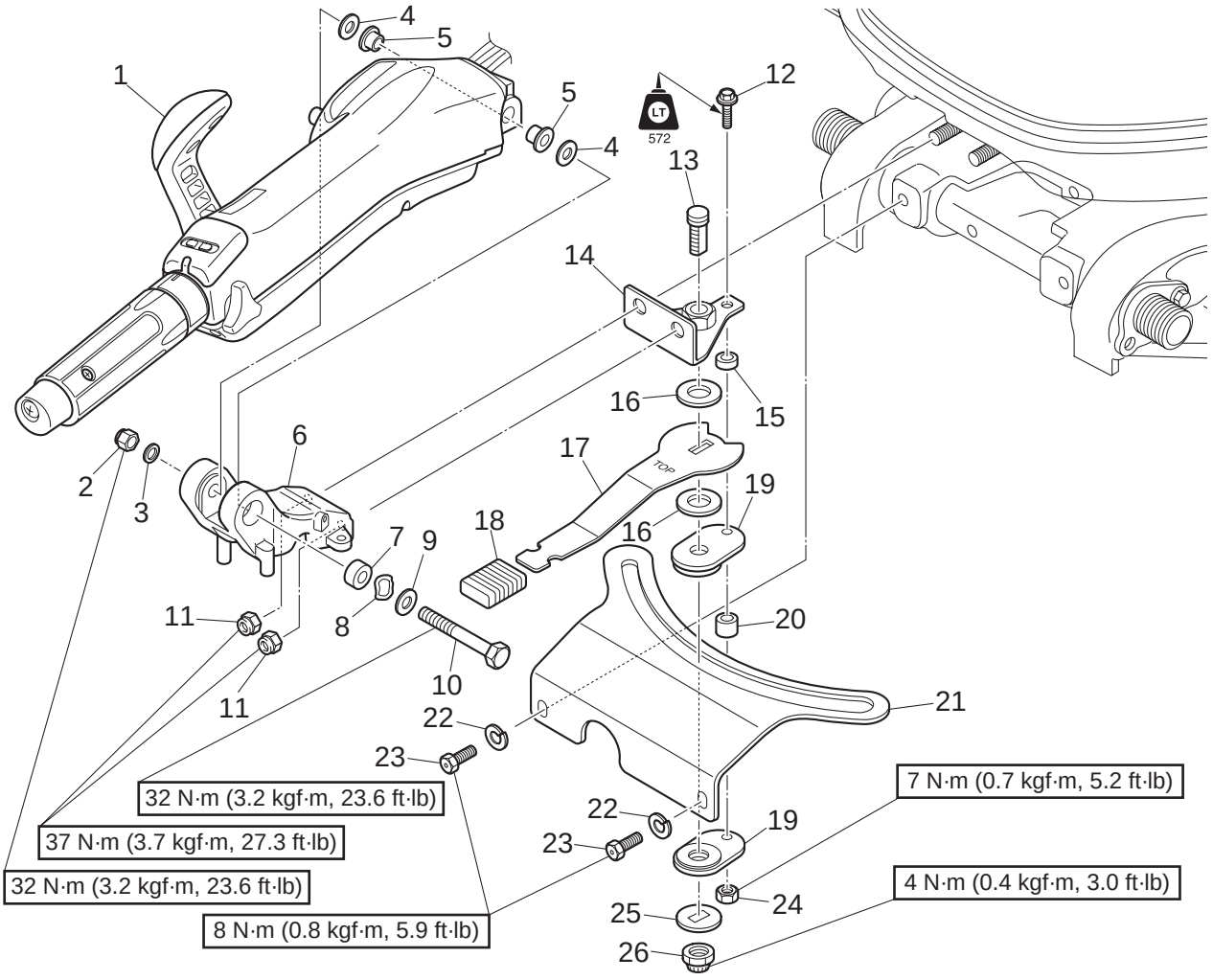
Steering friction



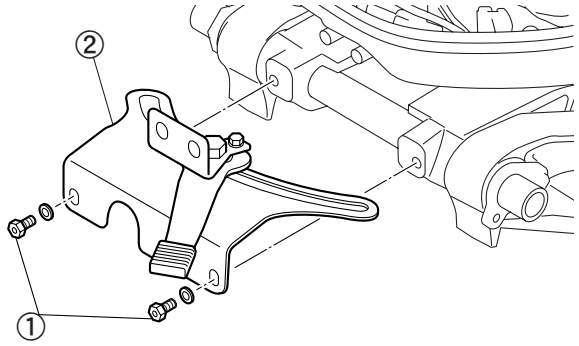
No.	Part name	Q'ty	Remarks
1	Tiller handle assembly	1	
2	Self-locking nut	1	
3	Washer	1	
4	Washer	2	
5	Bushing	2	
6	Tiller handle bracket	1	
7	Collar	1	
8	Wave washer	1	
9	Washer	1	
10	Bolt	1	M12 × 80 mm
11	Self-locking nut	2	
12	Bolt	1	M5 × 20 mm
13	Steering lock shaft	1	
14	Bracket	1	
15	Collar	1	
16	Washer	2	
17	Steering lock lever	1	



No.	Part name	Q'ty	Remarks
18	Cap	1	
19	Friction piece	2	
20	Collar	1	
21	Friction plate	1	
22	Spring washer	2	
23	Bolt	2	M6 × 12 mm
24	Nut	1	
25	Steering lock washer	1	
26	Friction adjusting nut	1	

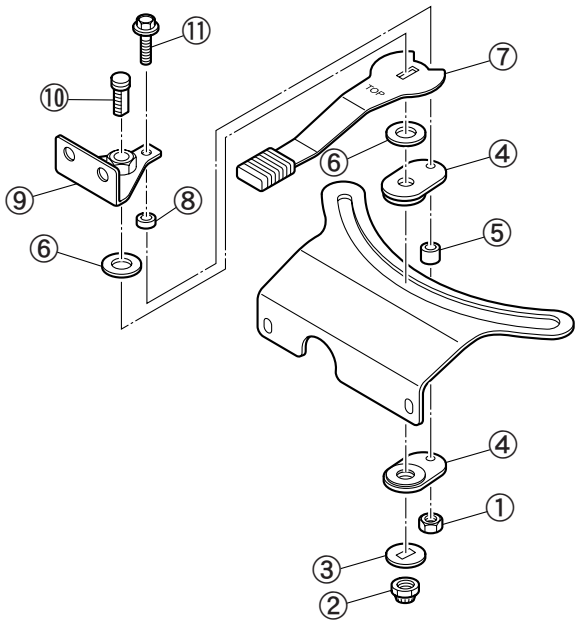
Removing the friction plate

1. Remove the friction plate bolts ①, and then remove the friction plate assembly ②.



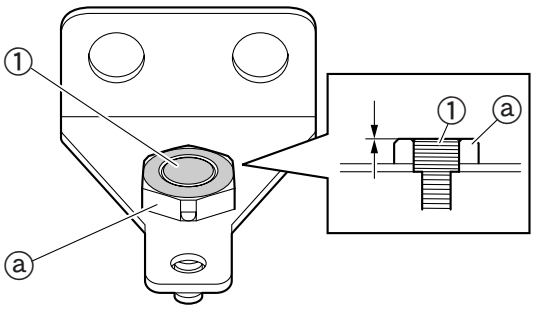
Disassembling the friction plate

1. Remove the friction plate nut ① and the friction adjusting nut ②, and then remove the steering lock washer ③, the friction pieces ④, the collar ⑤, the washers ⑥, the steering lock lever ⑦, the collar ⑧, the bracket ⑨, the steering lock shaft ⑩, and the bolt ⑪.

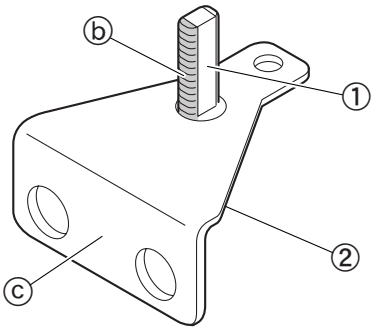


Assembling the friction plate

1. Screw in the steering lock shaft ① until its top surface comes level with the top surface of the nut ⓐ.



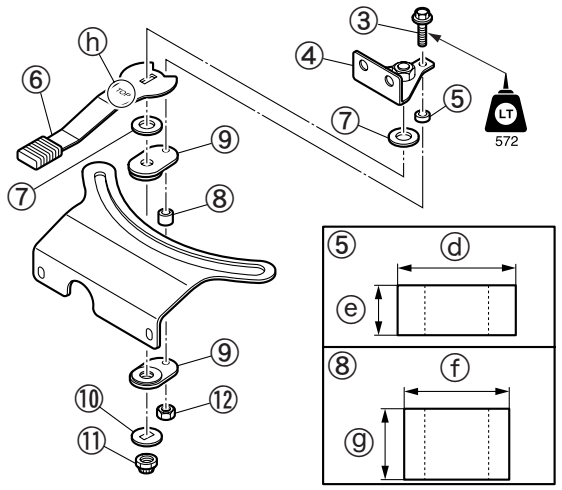
2. Turn the steering lock shaft ① until the thread side ⓑ faces toward the surface ⓒ of the bracket ②.



TIP:
Do not turn the steering lock shaft ① more than 90°.

3. Assemble the bolt ③, the bracket assembly ④, the collar ⑤, the steering lock lever ⑥, the washers ⑦, the collar ⑧, the friction pieces ⑨, and the steering lock washer ⑩, and then install the friction adjusting nut ⑪ and the friction plate nut ⑫ temporarily.

4. Tighten the friction plate nut ⑫ to the specified torque.



Friction plate nut ⑫:
7 N·m (0.7 kgf·m, 5.2 ft·lb)

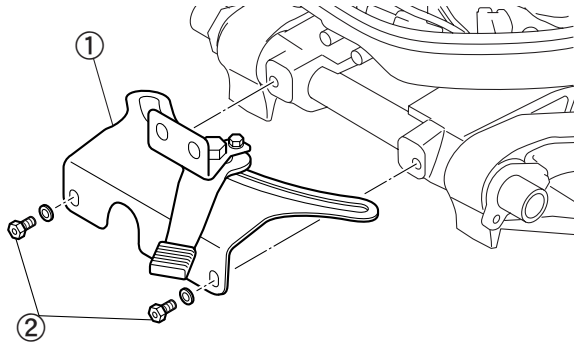
Collar ⑤ and ⑧ dimensions:
ⓓ: 9.0 mm (0.35 in)
ⓔ: 3.7 mm (0.15 in)
ⓕ: 8.0 mm (0.31 in)
ⓖ: 5.4 mm (0.21 in)

TIP:

- Make sure that the "TOP" mark ⓗ on the steering lock lever ⑥ is facing upwards.
- Make sure to install the collars ⑤ and ⑧ in the correct positions, as the collar dimensions are different.

Installing the friction plate assembly

1. Install the friction plate assembly ①, and then tighten the friction plate bolts ② to the specified torque.

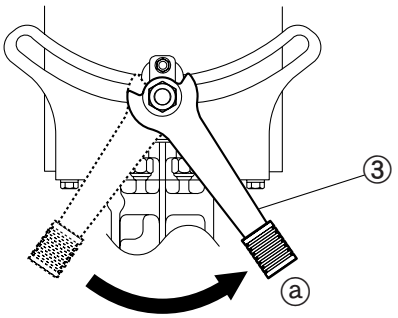


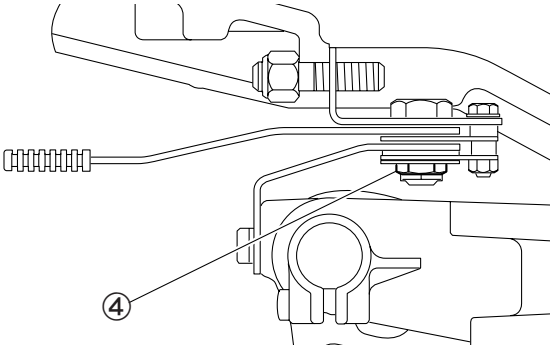
Friction plate bolt ②:
8 N·m (0.8 kgf·m, 5.9 ft·lb)

2. Install the tiller handle. See "Installing the tiller handle" (3-11).

3. Move the steering lock lever ③ to the position ⓐ, and then tighten the friction adjusting nut ④ to the specified torque.

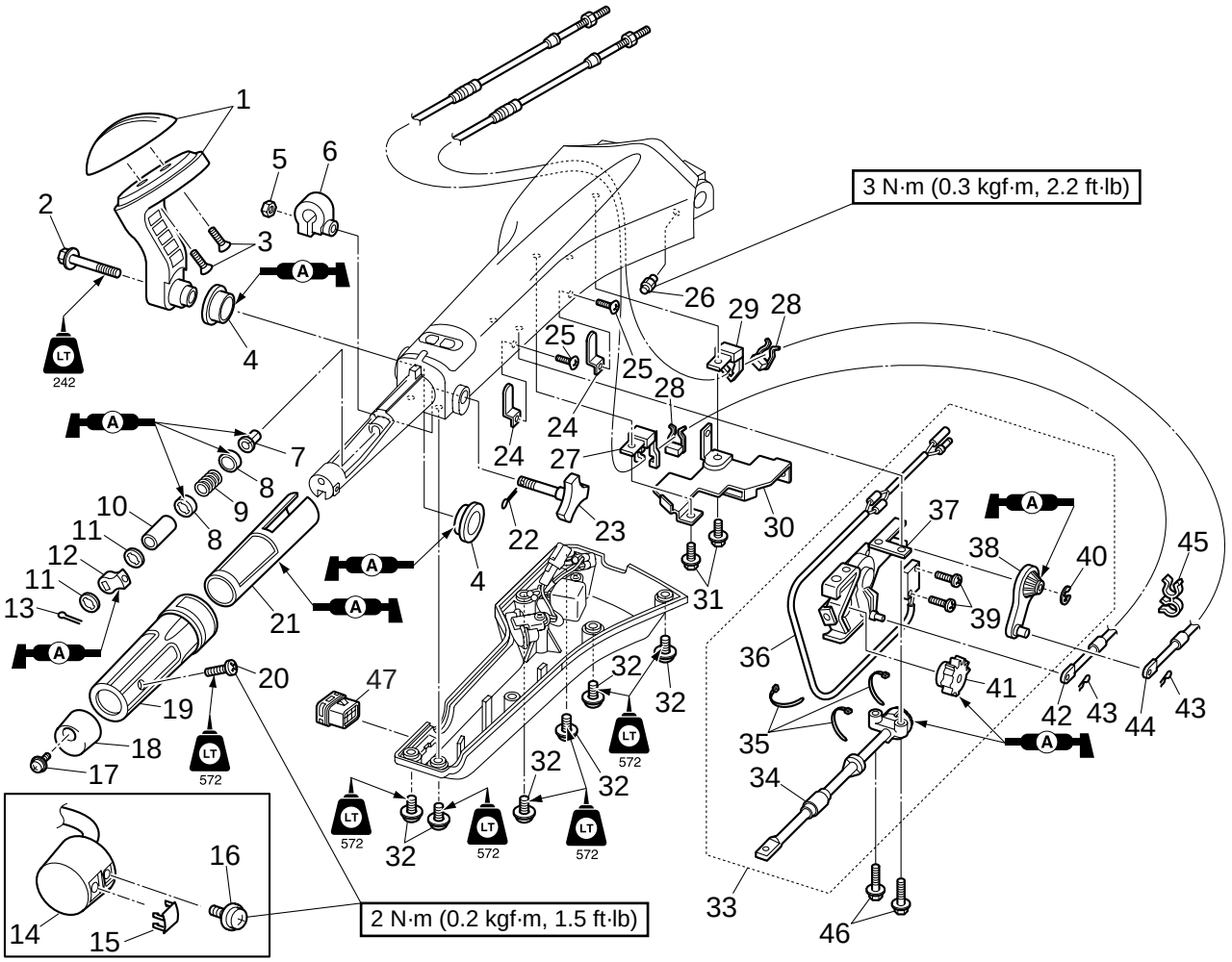
Friction adjusting nut ④:
4 N·m (0.4 kgf·m, 3.0 ft·lb)



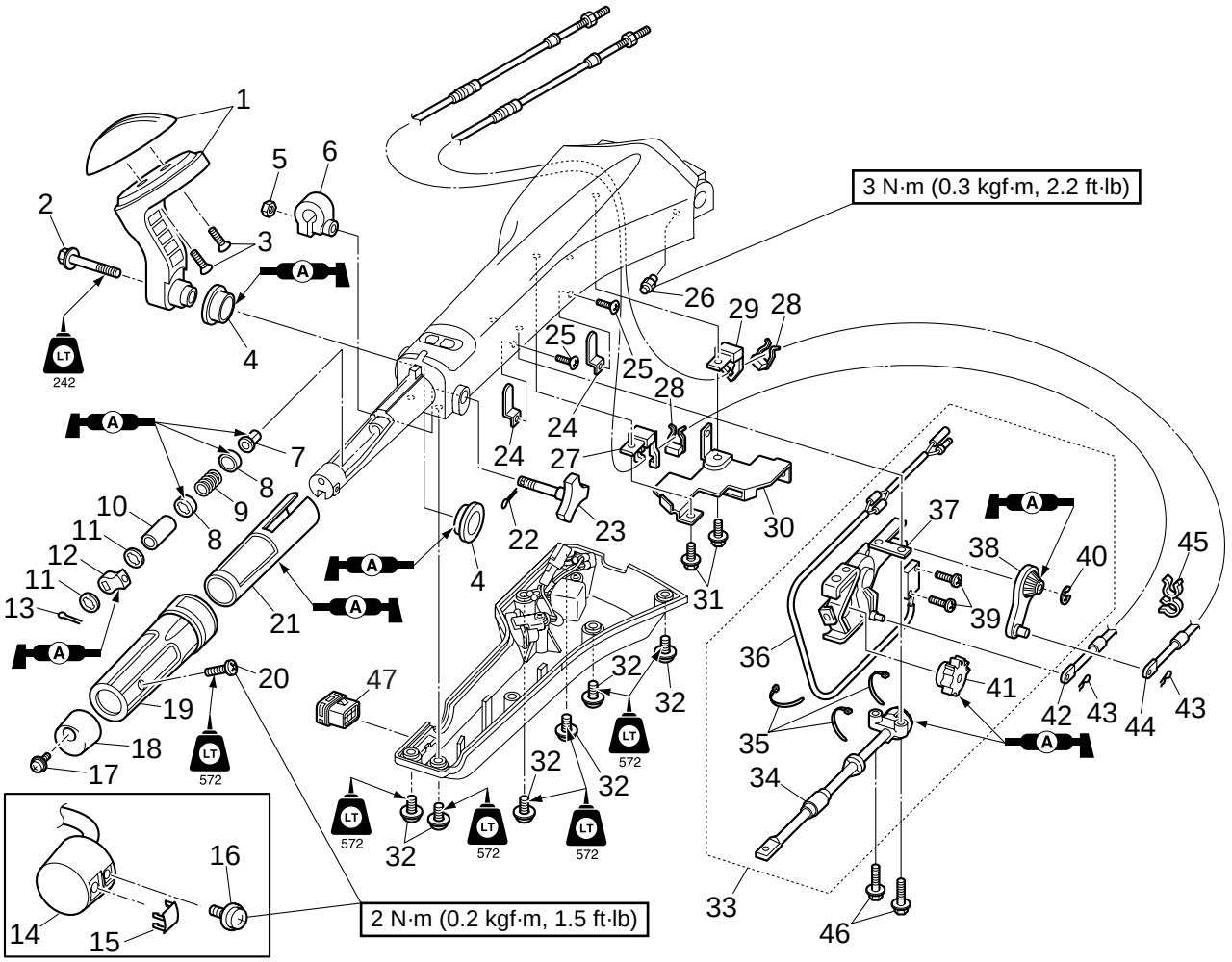


9

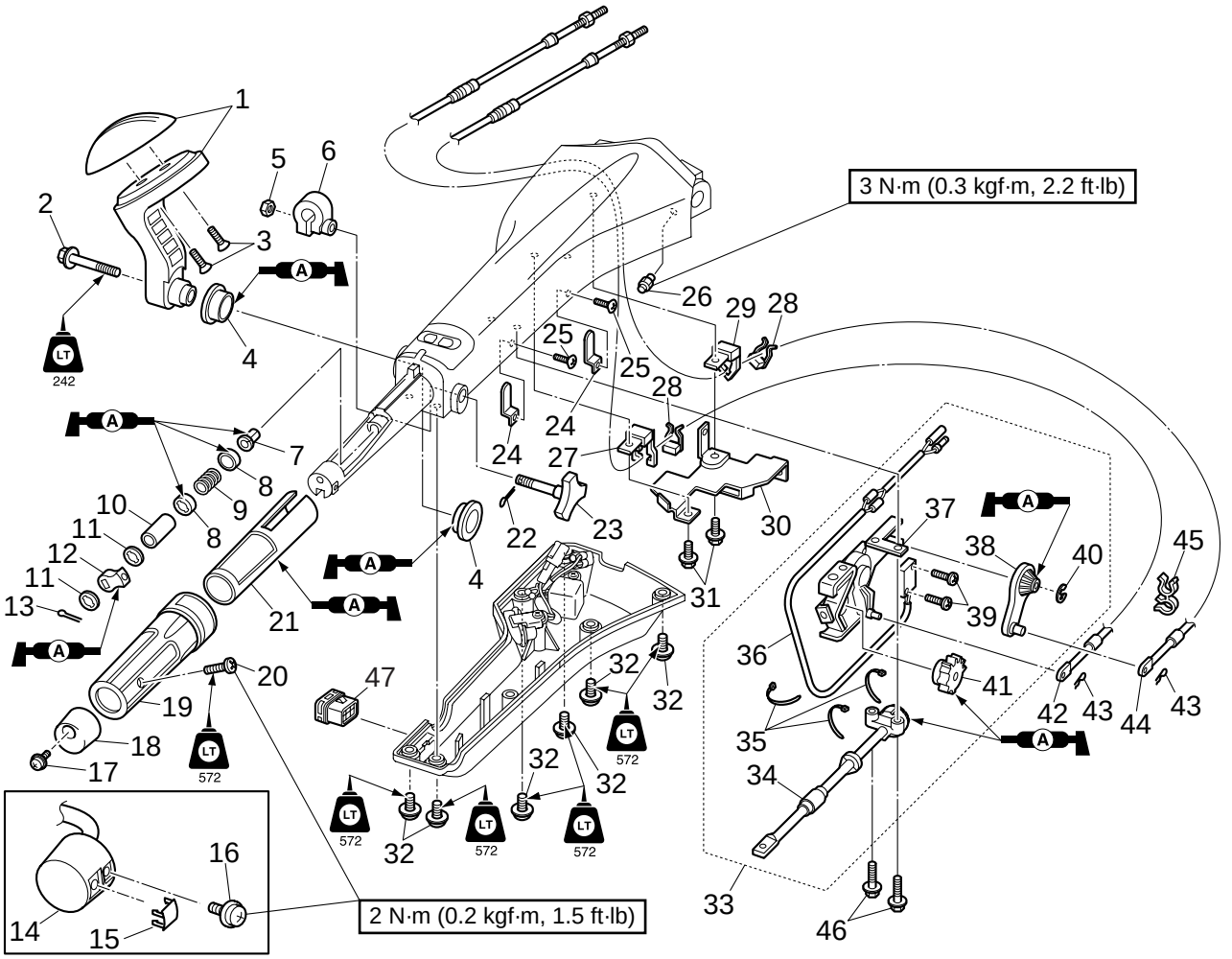
Tiller handle



No.	Part name	Q'ty	Remarks
1	Shift lever	1	
2	Bolt	1	M8 × 40 mm
3	Screw	2	ø6 × 16 mm
4	Bushing	2	
5	Nut	1	
6	Friction piece	1	
7	Bushing	1	
8	Retainer	2	
9	Spring	1	
10	Collar	1	
11	Washer	2	
12	Plate	1	
13	Cotter pin	1	**Not reusable**
14	PTT switch	1	PTT model
15	Cap	1	PTT model
16	Screw	1	M6 × 15 mm, PTT model
17	Screw	1	M6 × 15 mm, Hydro tilt model



No.	Part name	Q'ty	Remarks
18	Cap	1	Hydro tilt model
19	Throttle grip	1	
20	Screw	1	M5 × 22 mm
21	Bushing	1	
22	Cotter pin	1	**Not reusable**
23	Throttle friction adjuster	1	
24	Plate	2	PTT model
25	Screw	2	M4 × 10 mm, PTT model
26	Grease nipple	1	
27	Holder	1	
28	Clamp	2	
29	Holder	1	
30	Bracket	1	
31	Bolt	2	M6 × 30 mm
32	Screw	6	M6 × 15 mm
33	Control link assembly	1	
34	Throttle rod	1	

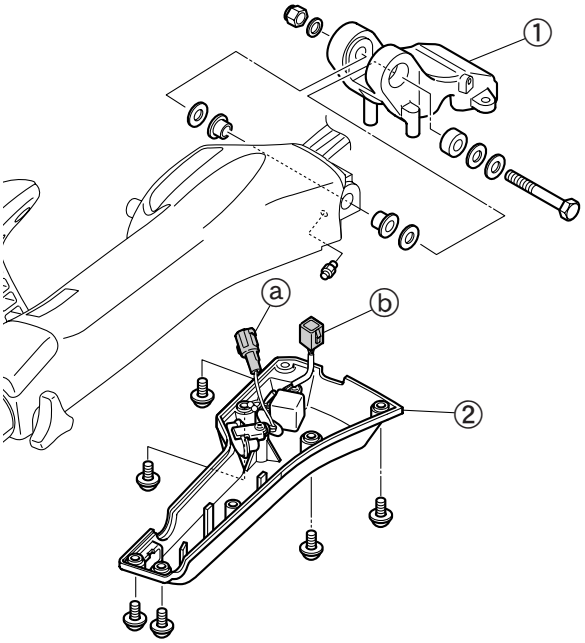


No.	Part name	Q'ty	Remarks
35	Plastic tie	3	**Not reusable**
36	Neutral switch	1	
37	Shift link	1	
38	Throttle lever	1	
39	Screw	2	M3 × 15 mm
40	E-clip	1	
41	Drive gear	1	
42	Shift cable	1	
43	Clip	2	
44	Throttle cable	1	
45	Holder	1	
46	Bolt	2	M6 × 30 mm
47	Cap	1	

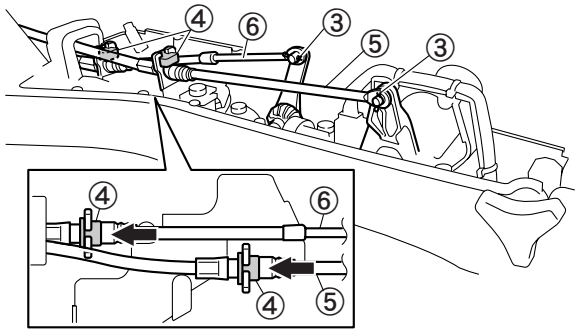
Disassembling the tiller handle

1. Remove the bracket ①.

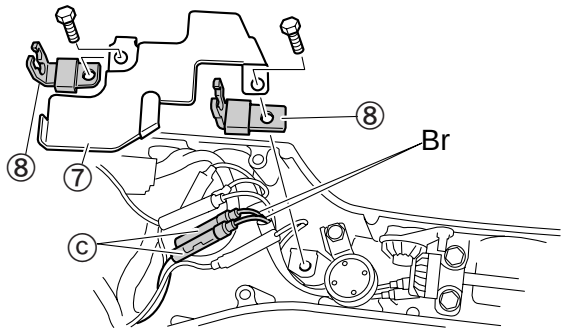
2. Remove the cover ②, and then disconnect the alert indicator couplers ⓐ and ⓑ.



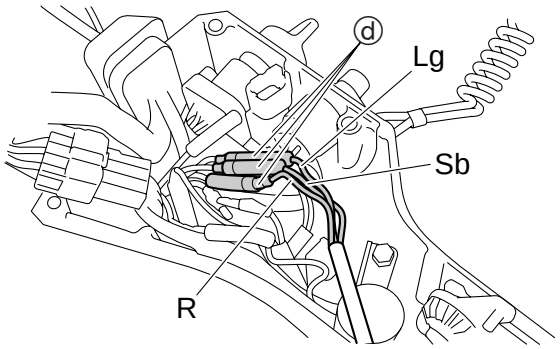
3. Remove the clips ③, and then remove the cable clamps ④, the shift cable ⑤, and the throttle cable ⑥.



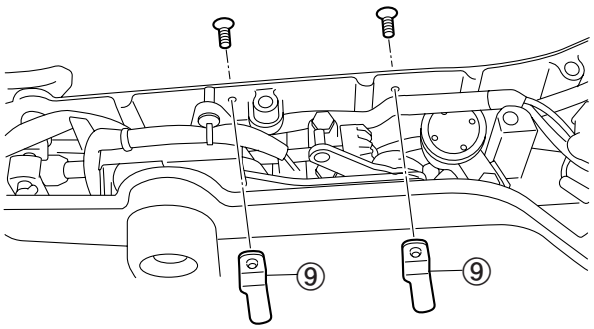
4. Remove the bracket ⑦ and the cable holders ⑧, and then disconnect the connectors ⓒ of the neutral switch Brown (Br) leads.



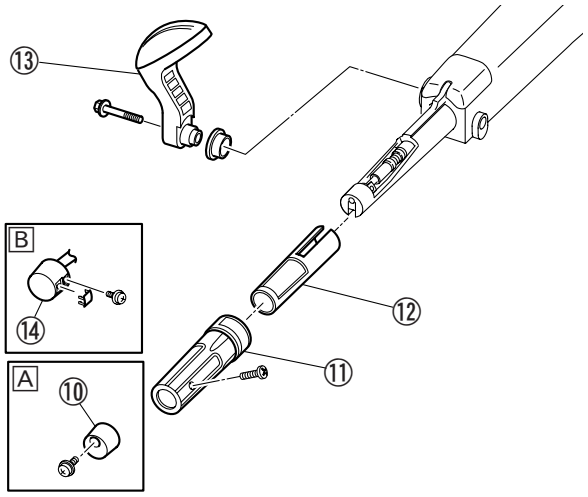
5. Disconnect the connectors ⓓ of the PTT switch Red (R) lead, the Sky blue (Sb) lead, and the Light green (Lg) lead (PTT model).



6. Remove the holders ⑨ (PTT model).

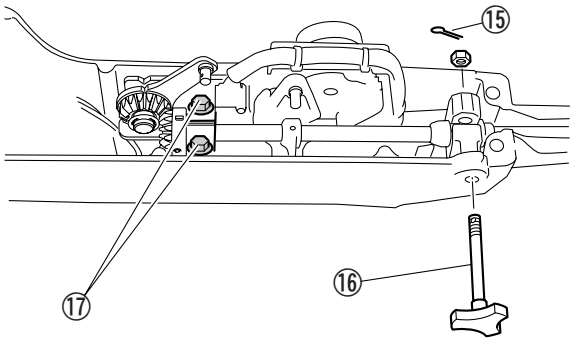


7. Remove the cap ⑩, the throttle grip ⑪, the bushing ⑫, and the shift lever ⑬ (hydro tilt model).
   Remove the PTT switch ⑭, the throttle grip ⑪, the bushing ⑫, and the shift lever ⑬ (PTT model).

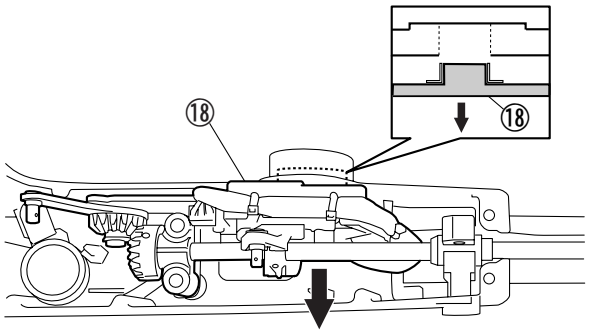


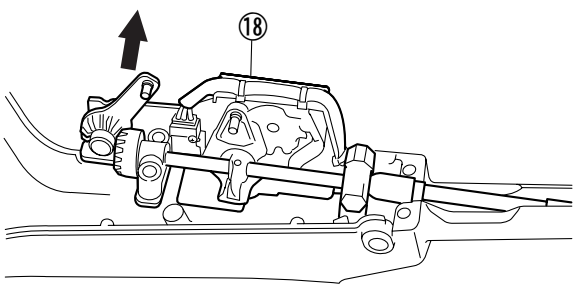
A Hydro tilt model
B PTT model

8. Remove the cotter pin ⑮, the throttle friction adjuster ⑯, and the bolts ⑰.

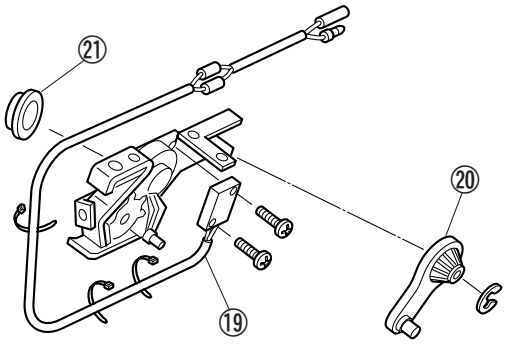


9. Pull out the control link assembly ⑱, and then move it upwards.

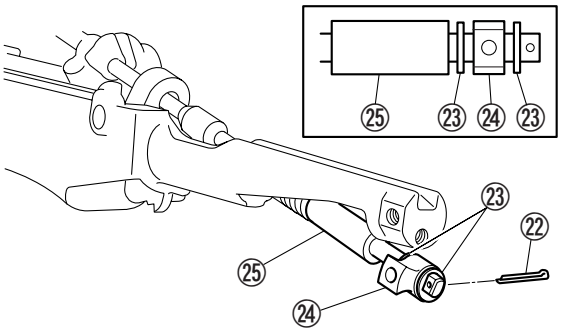




10. Remove the neutral switch ⑲, the throttle arm ⑳, and the bushing ㉑.

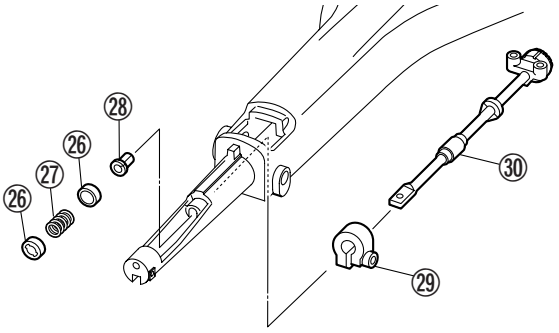


11. Remove the cotter pin ㉒, the washers ㉓, the plate ㉔, and the collar ㉕.



12. Remove the retainers ㉖, the spring ㉗, and the bushing ㉘.

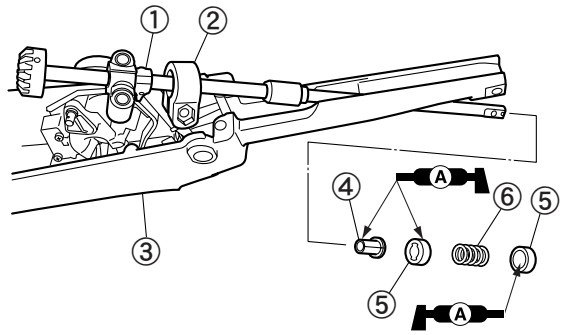
13. Remove the friction piece ㉙ and the throttle shaft ㉚.



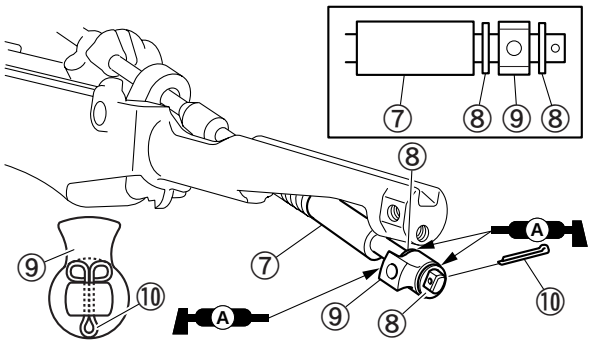
Assembling the tiller handle

1. Pass the throttle shaft ① through the friction piece ② and the tiller handle ③.

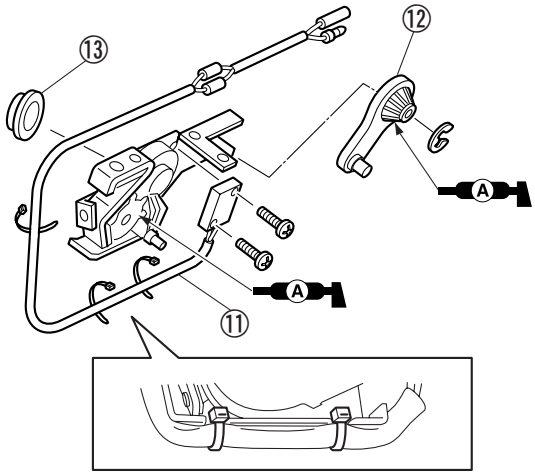
2. Install the bushing ④, the retainers ⑤, and the spring ⑥.



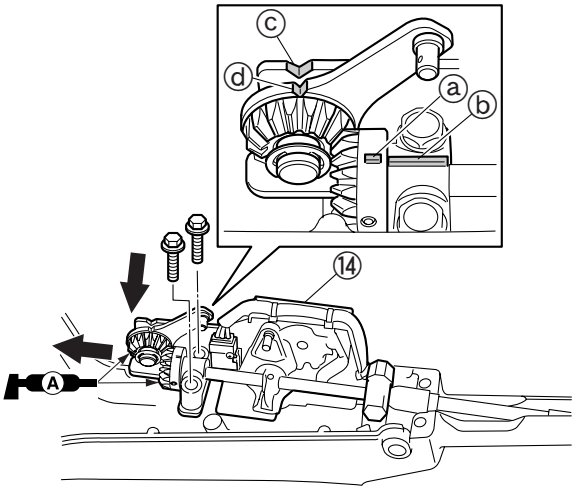
3. Install the collar ⑦, the washers ⑧, the plate ⑨, and a new cotter pin ⑩.



4. Install the neutral switch ⑪, the throttle arm ⑫, and the bushing ⑬.



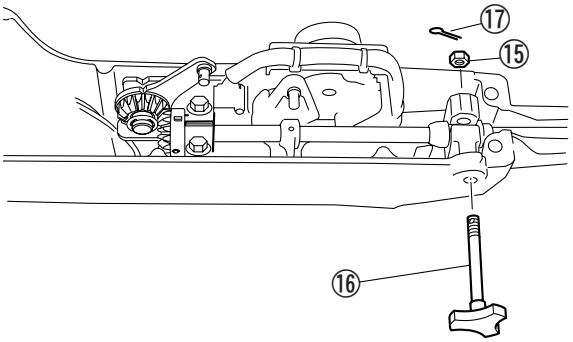
5. Align the marks ⓐ and ⓑ, and the cut-aways ⓒ and ⓓ, and then install the control link assembly ⑭.



TIP:

Run the neutral switch lead under the control link assembly ⑭. See “Tiller handle (tiller handle model)” (5-10).

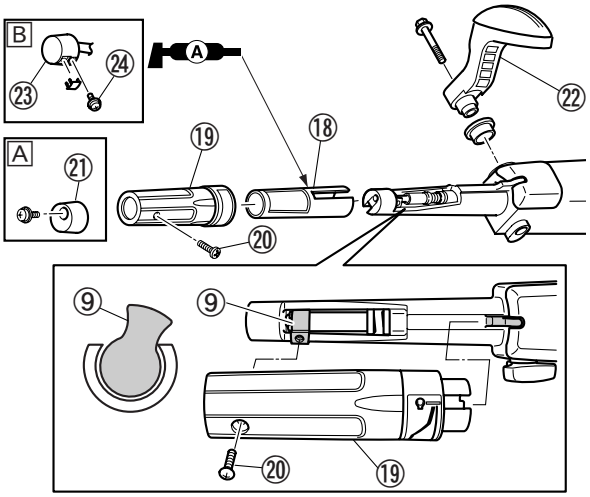
6. Install the nut ⑮, the throttle friction adjuster ⑯, and a new cotter pin ⑰.



7. Set the plate ⑨ to the direction shown, install the bushing ⑱ and the throttle grip ⑲, and then tighten the throttle grip screw ⑳ to the specified torque.

8. Install the cap ㉑, and the shift lever ㉒ (hydro tilt model).
   Install the PTT switch ㉓, and the shift lever ㉒, and then tighten the PTT switch screw ㉔ to the specified torque (PTT model).

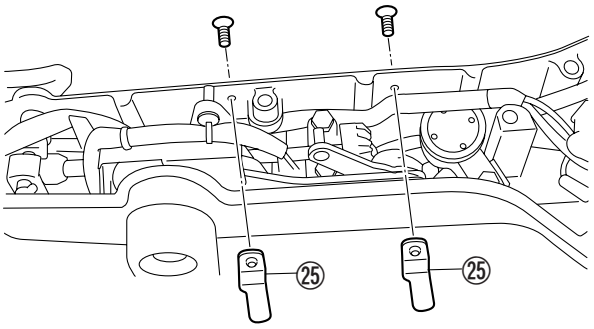
9



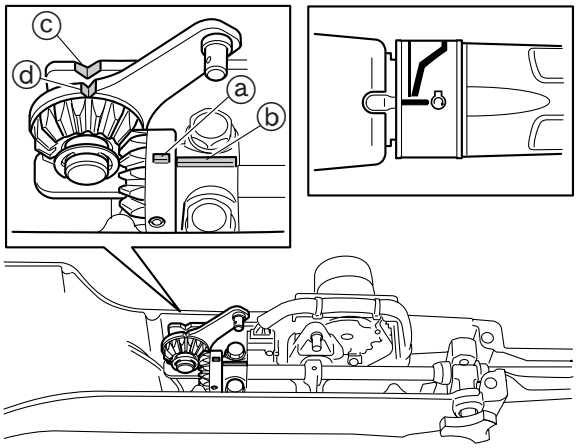
A Hydro tilt model
B PTT model

Throttle grip screw ⑳: 2 N·m (0.2 kgf·m, 1.5 ft·lb) PTT switch screw ㉔: 2 N·m (0.2 kgf·m, 1.5 ft·lb)

9. Install the holders ㉕ (PTT model).

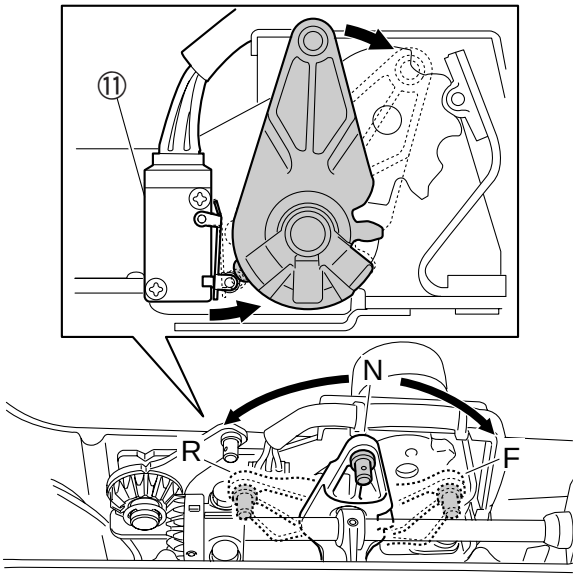


10. Check that the throttle grip operates smoothly, and then check that the marks ⓐ and ⓑ are aligned, and that the cut-aways ⓒ and ⓓ are also aligned.

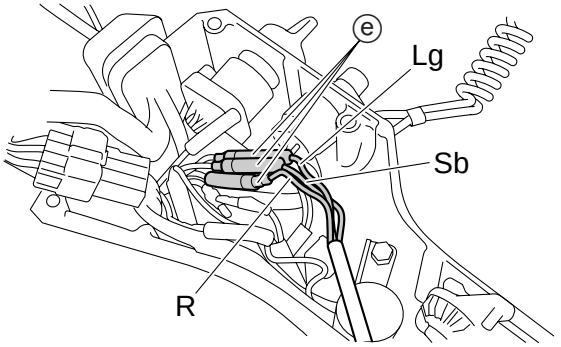


11. Check that the shift link lever operates smoothly when the shift lever is shifted from the N to the F or R position.

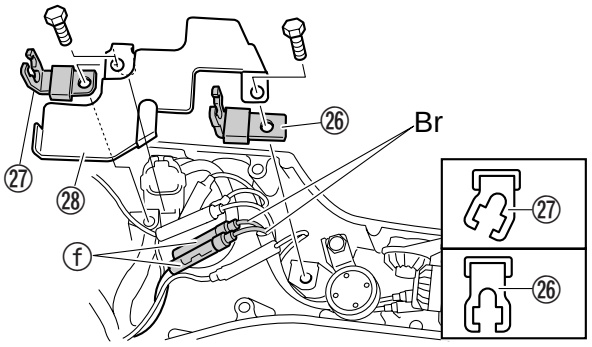
12. Check that the neutral switch ⑪ operates properly.



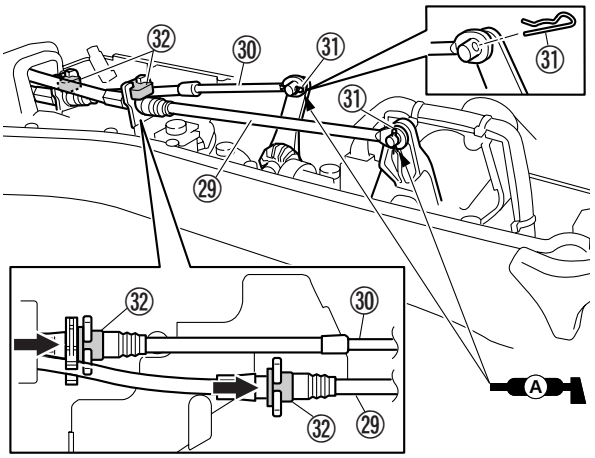
13. Connect the connectors ⓔ of the PTT switch Red (R) lead, the Sky blue (Sb) lead, and the Light green (Lg) lead (PTT model).



14. Connect the connectors ⓕ of the neutral switch Brown (Br) leads, and then install the holders ㉖, ㉗, and the bracket ㉘.



15. Install the shift cable ㉙, the throttle cable ㉚, the clips ㉛, and the cable clamps ㉜.



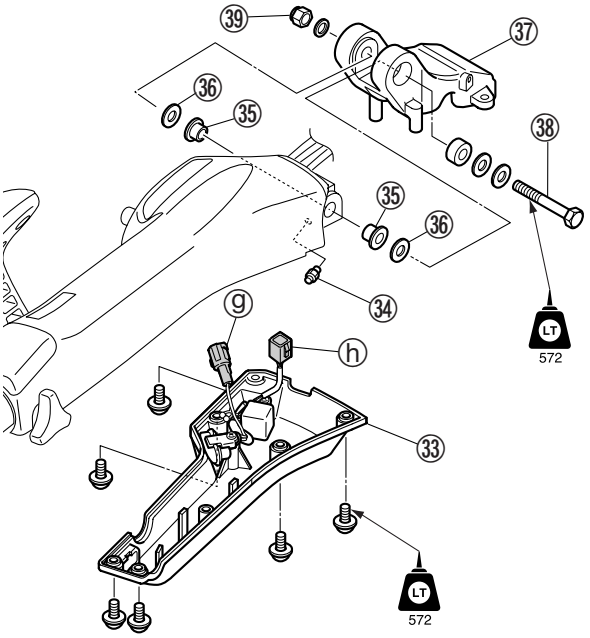
16. Connect the alert indicator couplers ⓖ and ⓗ, and then install the cover ㉝.

17. Install the grease nipple ㉞, and then tighten it to the specified torque.

18. Install the bushings ㉟, the washers ㊱, and then install the bracket ㊲.

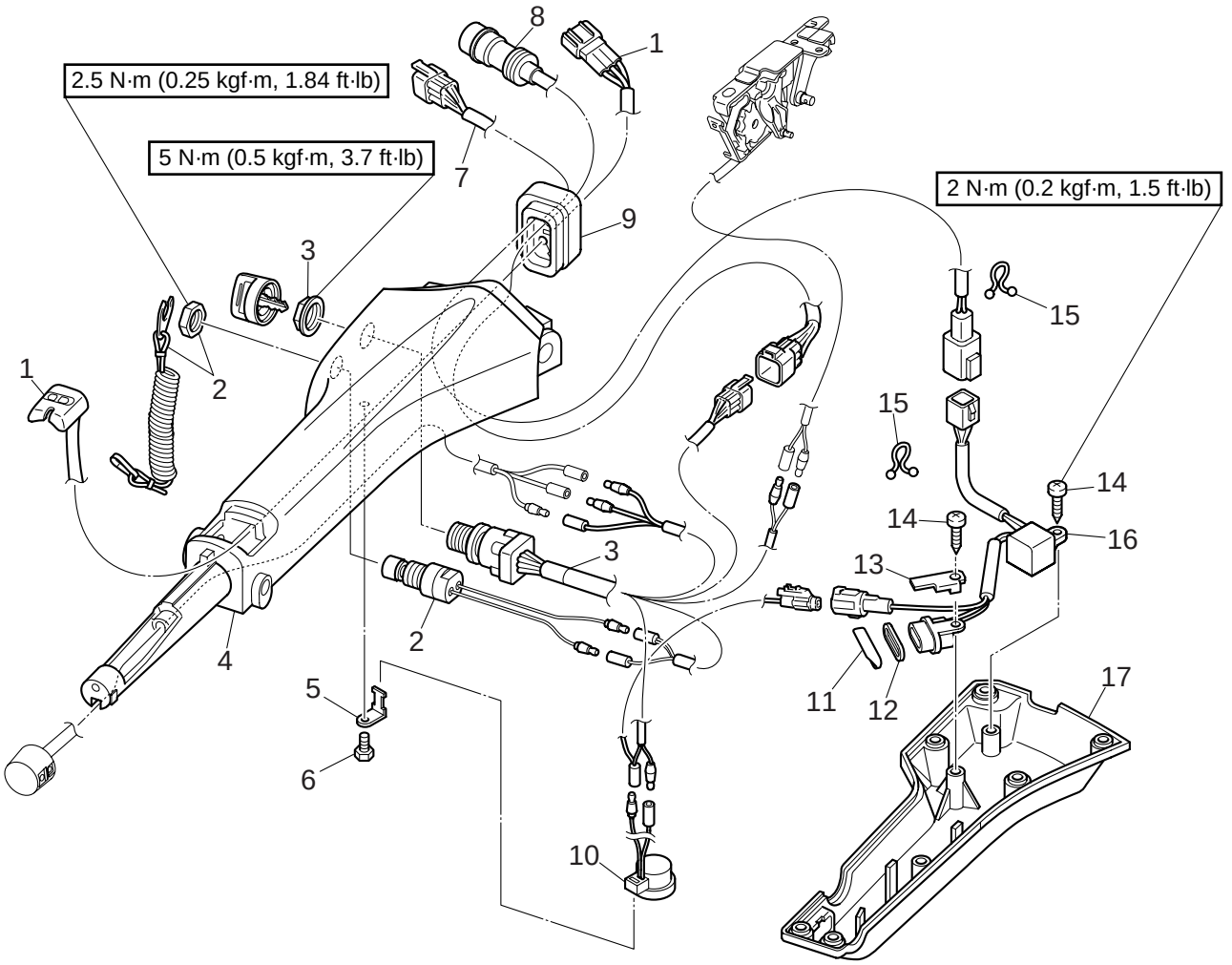
19. Tighten the tiller handle bracket bolt ㊳ to the specified torque.

20. Tighten the tiller handle bracket nut ㊴ to the specified torque.



Grease nipple ㉞: 3 N·m (0.3 kgf·m, 2.2 ft·lb) Tiller handle bracket bolt ㊳: 32 N·m (3.2 kgf·m, 23.6 ft·lb) Tiller handle bracket nut ㊴: 32 N·m (3.2 kgf·m, 23.6 ft·lb)

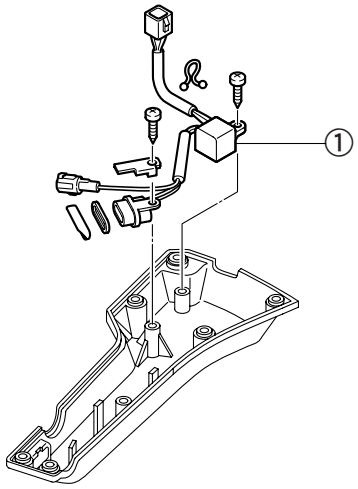
Electrical components (multifunction)



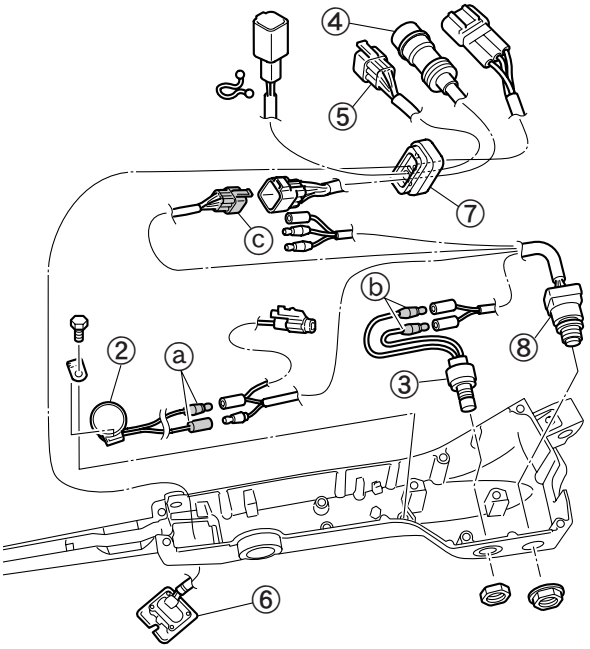
No.	Part name	Q'ty	Remarks
1	Trolling switch	1	
2	Engine shut-off switch	1	
3	Engine start switch	1	
4	Tiller handle	1	
5	Bracket	1	
6	Bolt	1	M6 × 15 mm
7	Alert indicator harness	1	
8	Extension wiring harness	1	
9	Grommet	1	
10	Buzzer	1	
11	Grommet	1	
12	Gasket	1	
13	Plate	1	
14	Screw	2	ø6 × 20 mm
15	Clamp	2	
16	Alert indicator	1	
17	Cover	1	

Disassembling the electrical components (multifunction)

1. Remove the alert indicator ①.

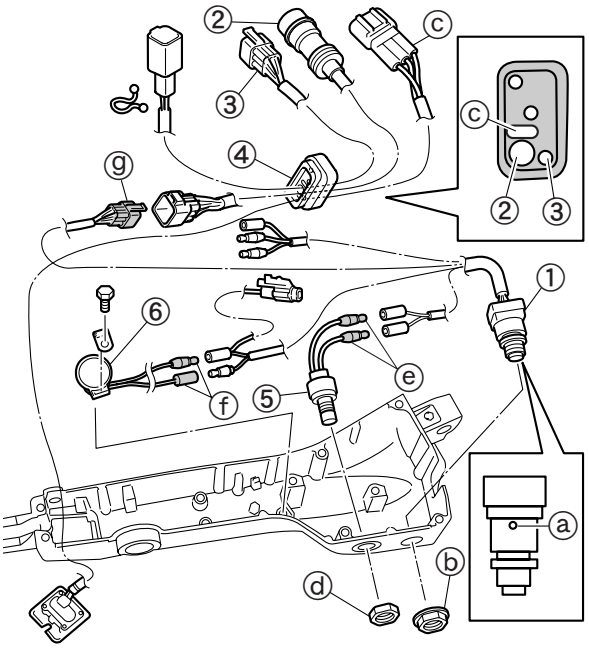


2. Remove the buzzer ②, and then disconnect the buzzer connectors ⓐ and the engine shut-off switch connectors ⓑ.
3. Remove the engine shut-off switch ③.
4. Disconnect the engine start switch coupler ⓒ.
5. Remove the extension wiring harness ④, the alert indicator harness ⑤, the trolling switch ⑥, and the grommet ⑦.
6. Remove the engine start switch ⑧.

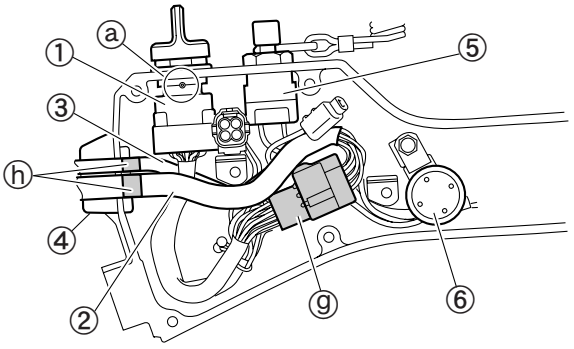


Assembling the electrical components (multifunction)

1. Install the engine start switch ① with the hole ⓐ facing upward, and then tighten the start switch nut ⓑ to the specified torque.
2. Pass the extension wiring harness ②, the alert indicator harness ③, and the trolling switch lead ⓒ through the grommet ④, and then install them.
3. Install the engine shut-off switch ⑤, and then tighten the engine shut-off switch nut ⓓ to the specified torque.
4. Install the buzzer ⑥, and then connect the engine shut-off switch connectors ⓔ and the buzzer connectors ⓕ.
5. Connect the engine start switch coupler ⓖ.
6. Align the white tapes ⓗ on the extension wiring harness ② and the alert indicator harness ③ with the inner end of the grommet ④.

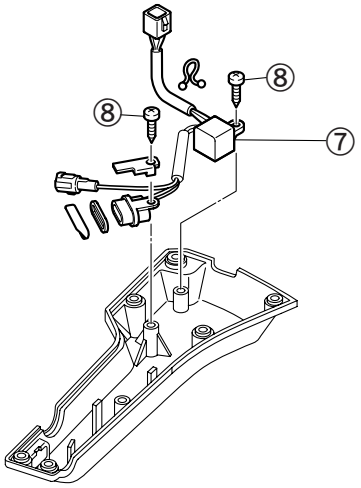


9



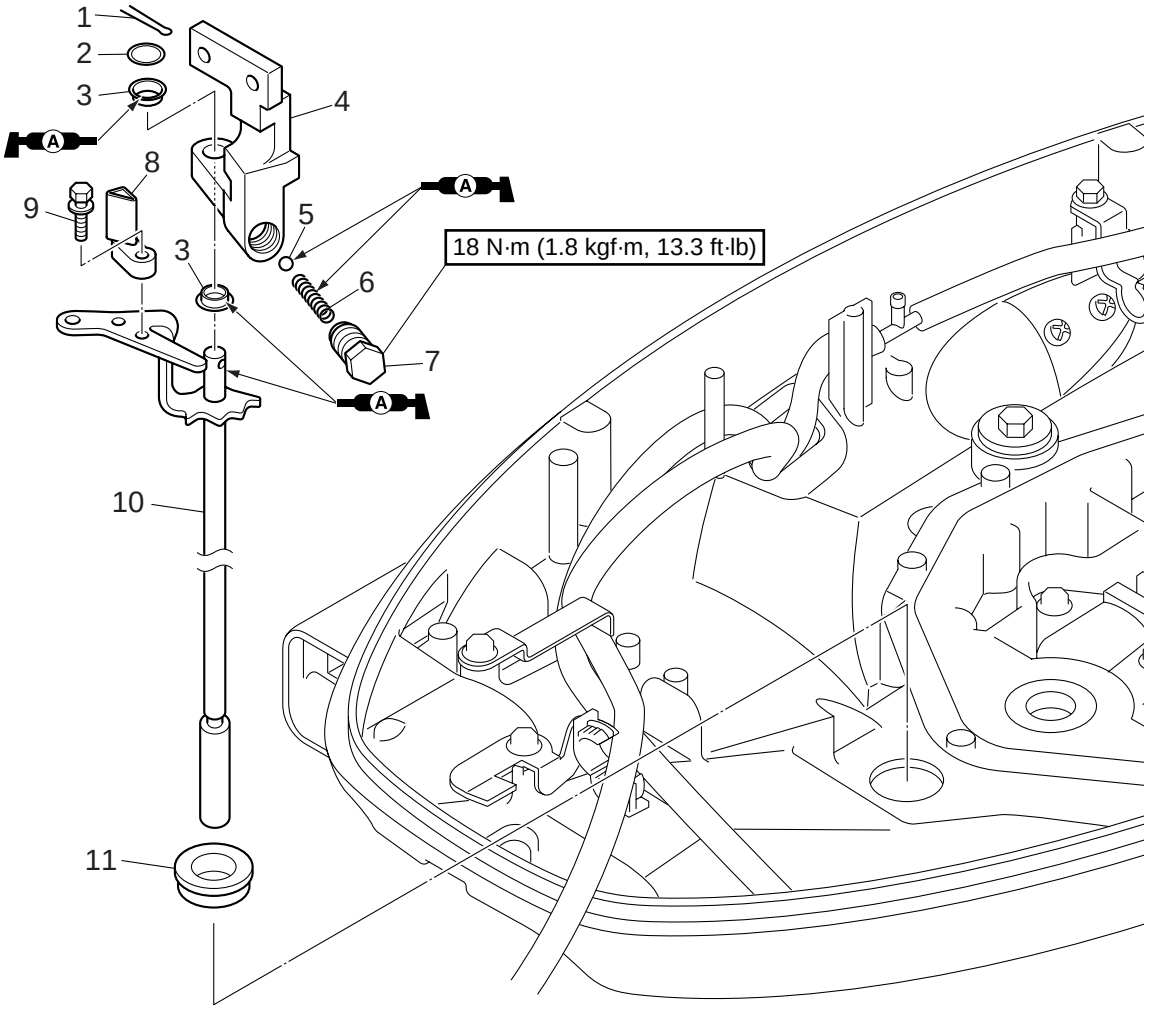
Engine start switch nut ⓑ: 5 N·m (0.5 kgf·m, 3.7 ft·lb) Engine shut-off switch nut ⓓ: 2.5 N·m (0.25 kgf·m, 1.84 ft·lb)

7. Install the alert indicator ⑦, and then tighten the alert indicator screws ⑧ to the specified torque.



Alert indicator screw ⑧: 2 N·m (0.2 kgf·m, 1.5 ft·lb)

Shift rod and shift bracket

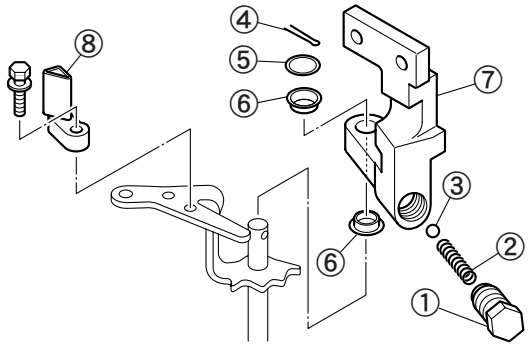


No.	Part name	Q'ty	Remarks
1	Cotter pin	1	**Not reusable**
2	Washer	1	
3	Bushing	2	
4	Bracket	1	
5	Ball	1	
6	Spring	1	
7	Detent bolt	1	
8	Bushing	1	
9	Bolt	1	M5 × 14 mm
10	Shift rod	1	
11	Grommet	1	

Disassembling the shift rod

1. Remove the shift rod detent bolt ①, the spring ②, and the ball ③.

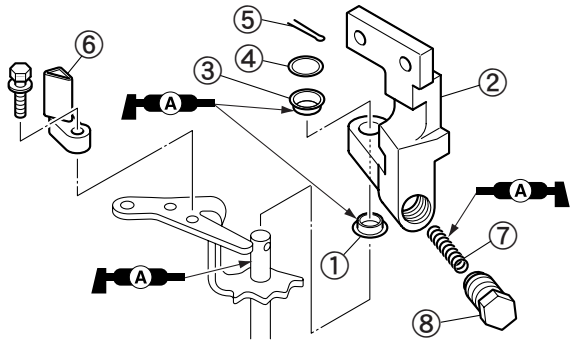
2. Remove the cotter pin ④, and then remove the washer ⑤, the bushings ⑥, the bracket ⑦, and the bushing ⑧.



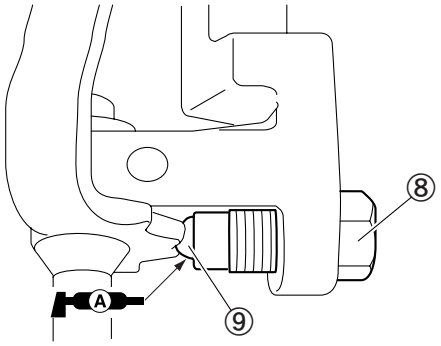
Assembling the shift rod

1. Install the bushing ①, the bracket ②, the bushing ③, the washer ④, the cotter pin ⑤, and the bushing ⑥.

2. Install the spring ⑦ into the shift rod detent bolt ⑧, and then tighten the shift rod detent bolt ⑧ temporarily.

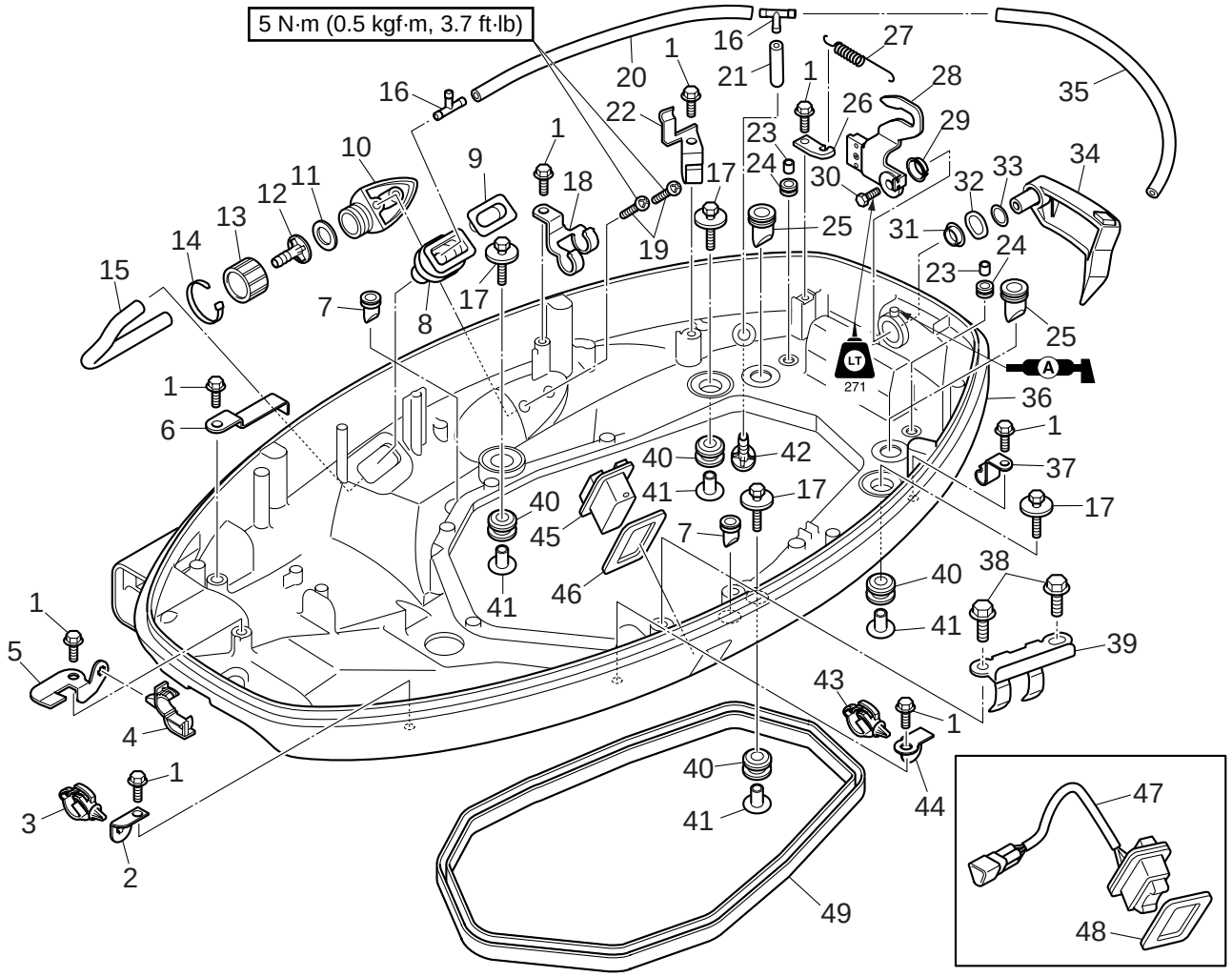


3. Install the ball ⑨, and then tighten the shift rod detent bolt ⑧ to the specified torque.

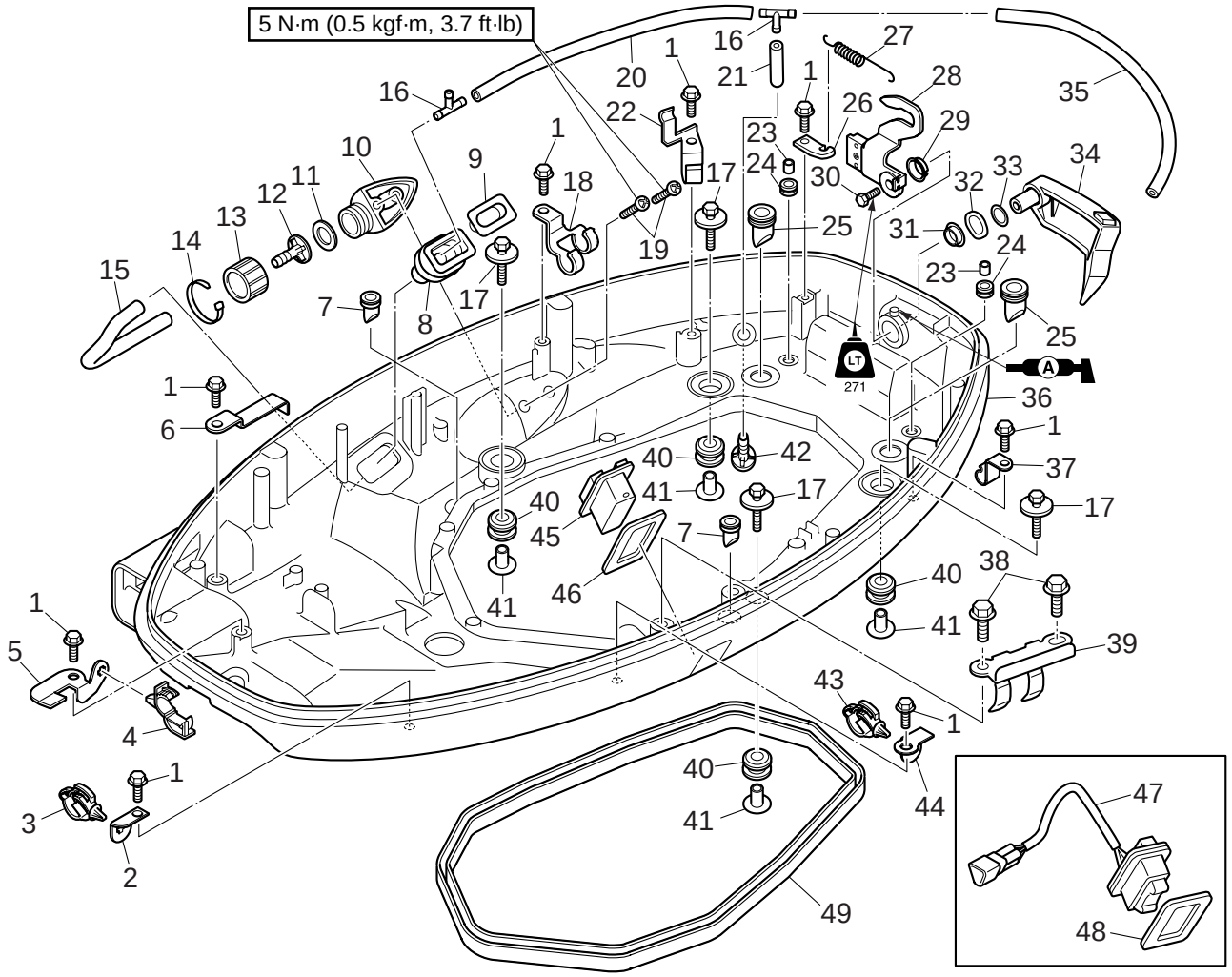


Shift rod detent bolt ⑧:
18 N·m (1.8 kgf·m, 13.3 ft·lb)

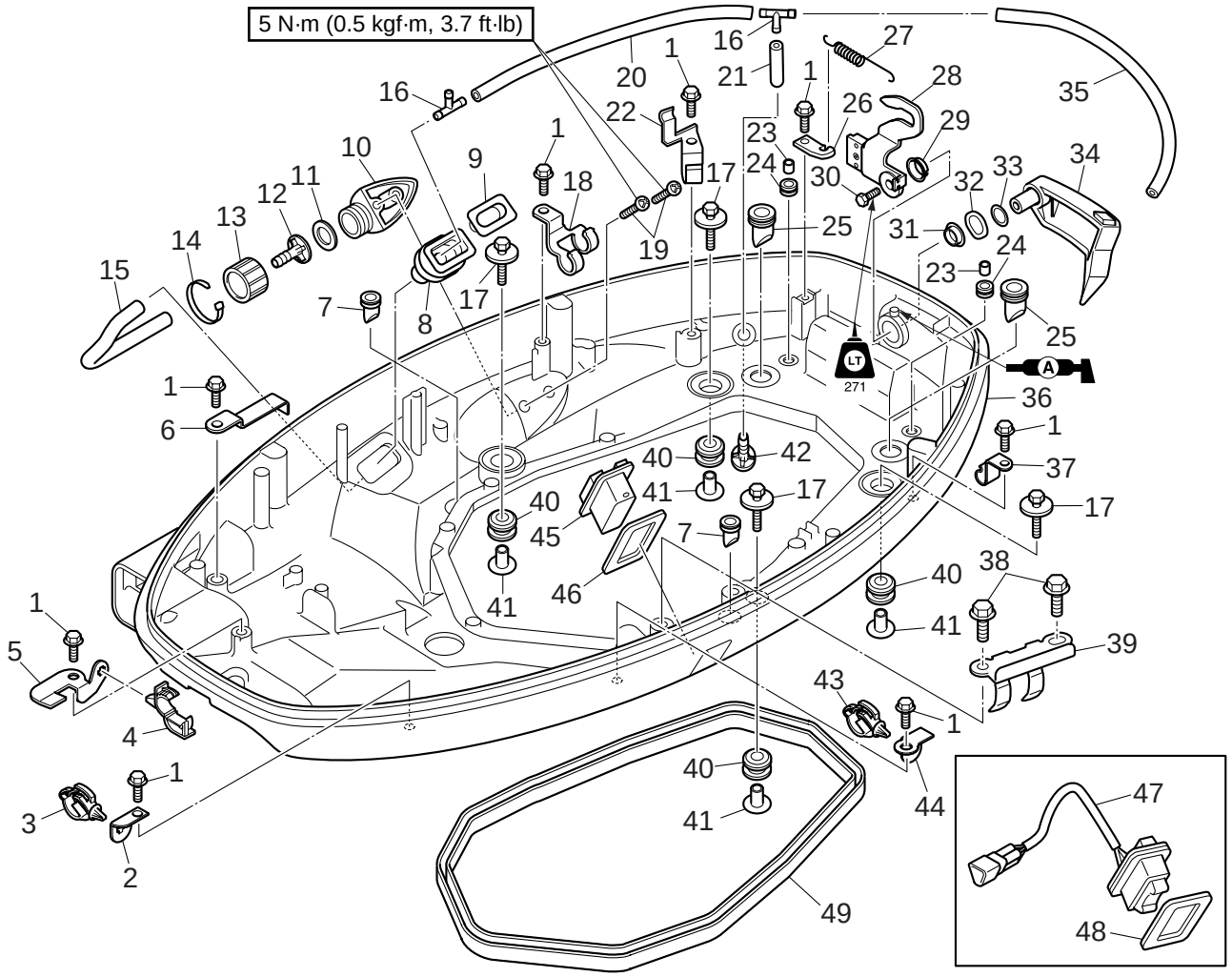
Bottom cowling



No.	Part name	Q'ty	Remarks
1	Bolt	8	M6 × 20 mm
2	Bracket	1	
3	Clamp	1	
4	Clamp	1	
5	Bracket	1	
6	Plate	1	
7	Grommet	2	
8	Grommet	1	
9	Cap	1	
10	Adapter	1	
11	Gasket	1	
12	Hose joint	1	
13	Hose joint	1	
14	Plastic tie	1	**Not reusable**
15	Hose	1	
16	Hose joint	2	
17	Bolt	4	M6 × 30 mm



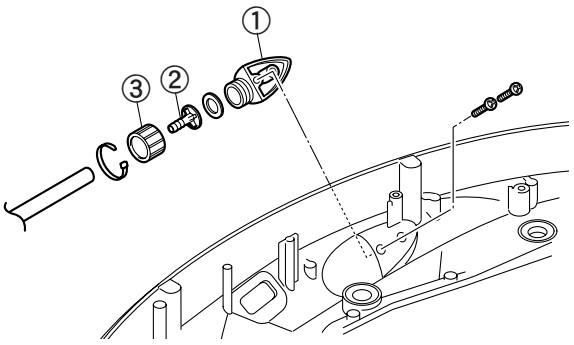
No.	Part name	Q'ty	Remarks
18	Holder	1	
19	Screw	2	ø6 × 19 mm
20	Hose	1	
21	Hose	1	
22	Holder	1	
23	Collar	2	
24	Grommet	2	
25	Grommet	2	
26	Hook	1	
27	Spring	1	
28	Lever	1	
29	Bushing	1	
30	Bolt	1	M6 × 14 mm
31	Bushing	1	
32	Wave washer	1	
33	Washer	1	
34	Cowling lock lever	1	



No.	Part name	Q'ty	Remarks
35	Hose	1	
36	Bottom cowling	1	
37	Holder	1	
38	Bolt	2	M6 × 20 mm
39	Bracket	1	
40	Grommet	4	
41	Collar	4	
42	Water outlet	1	
43	Clamp	1	
44	Bracket	1	
45	Cover	1	
46	Gasket	1	
47	PTT switch	1	Remote control model with PTT
48	Gasket	1	Remote control model with PTT
49	Rubber seal	1	

Removing the flushing hose

1. Remove the adapter ① and the hose joints ② and ③.

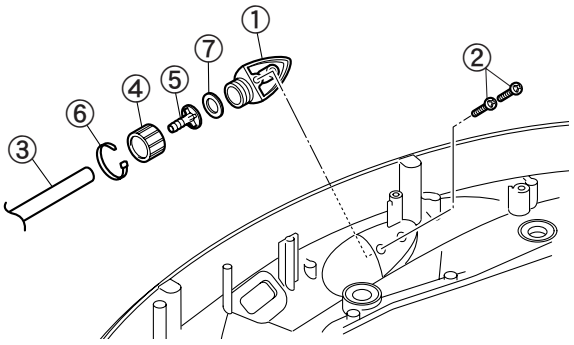


Installing the flushing hose

1. Install the flushing hose adapter ①, and then tighten the flushing hose adapter screws ② to the specified torque.

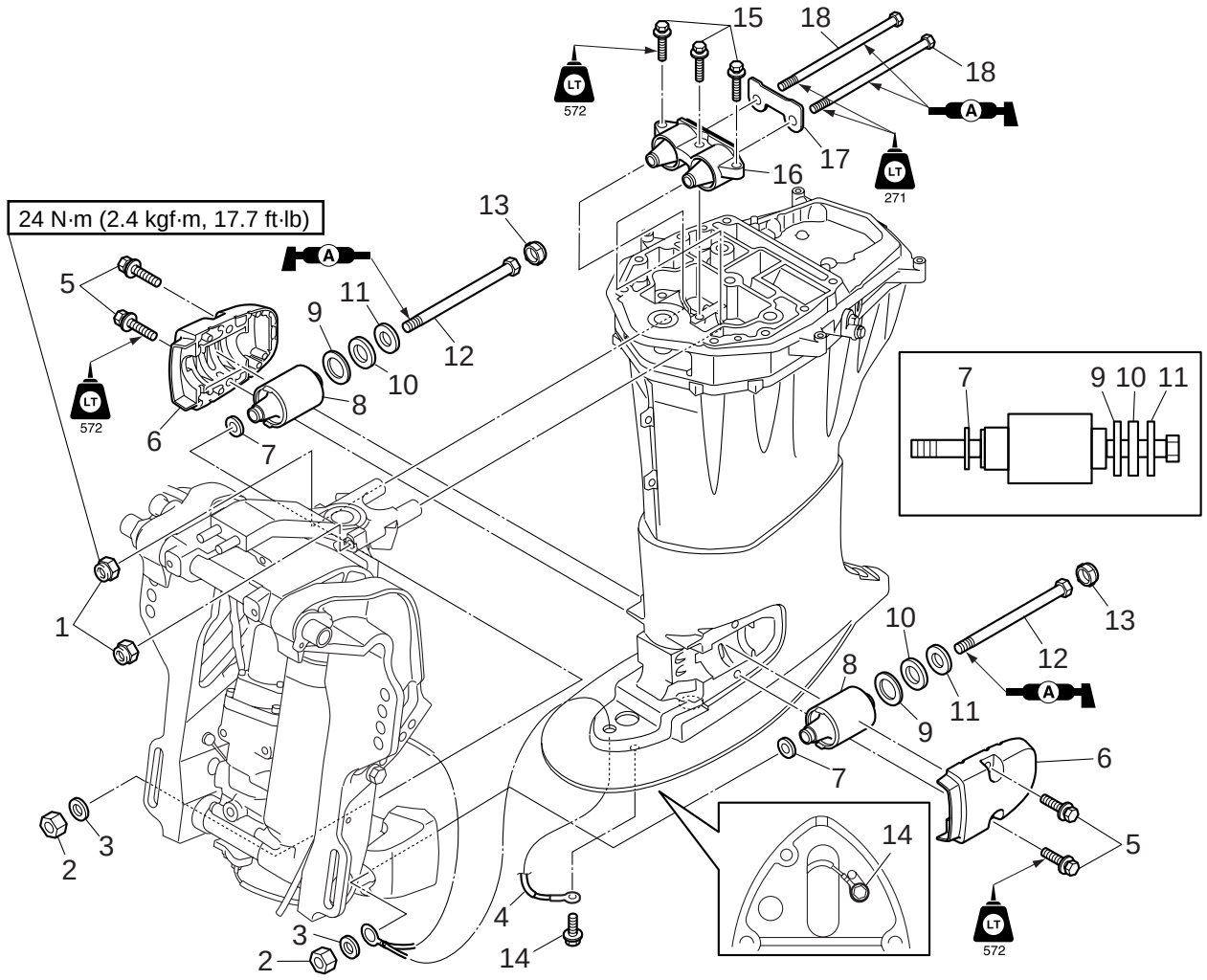
2. Pass the flushing hose ③ through the hose joint ④ and install it to the hose joint ⑤, and then fasten the flushing hose ③ with a new plastic tie ⑥.

3. Install them to the adapter ① with the gasket ⑦.

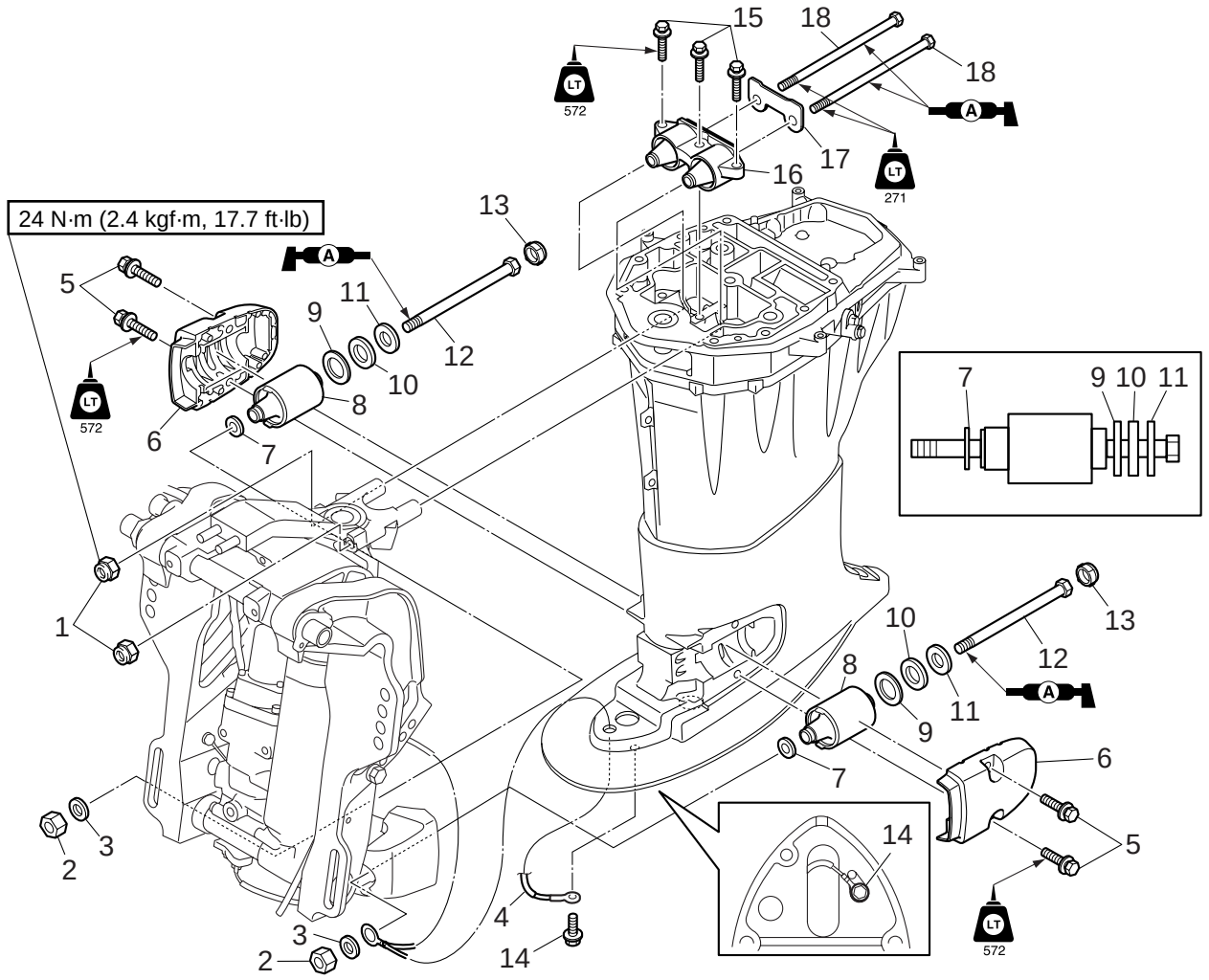


Flushing hose adapter screw ②: 5 N·m (0.5 kgf·m, 3.7 ft·lb)

Upper case and mounts



No.	Part name	Q'ty	Remarks
1	Self-locking nut	2	
2	Nut	2	
3	Washer	2	
4	Ground lead	1	
5	Bolt	4	M8 × 30 mm
6	Cover	2	
7	Washer	2	
8	Lower mount	2	
9	Washer	2	
10	Rubber washer	2	
11	Washer	2	
12	Bolt	2	M12 × 170 mm
13	Cap	2	
14	Bolt	1	M6 × 7 mm
15	Bolt	3	M8 × 30 mm
16	Upper mount	1	
17	Plate	1	



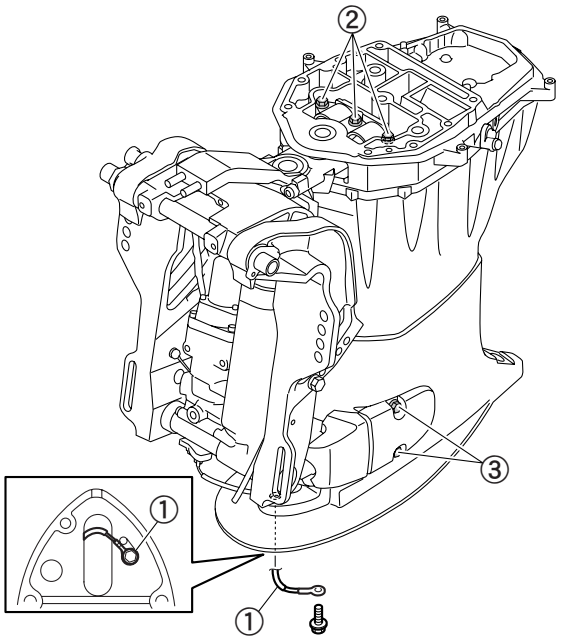
No.	Part name	Q'ty	Remarks
18	Bolt	2	M8 × 175 mm

Removing the upper case

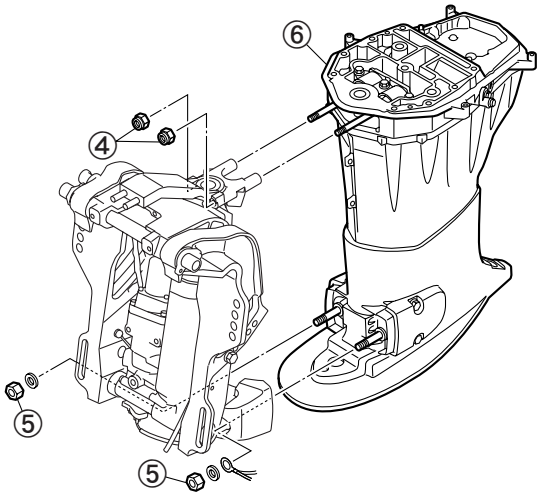
1. Drain the remaining engine oil.

2. Remove the ground lead ①.

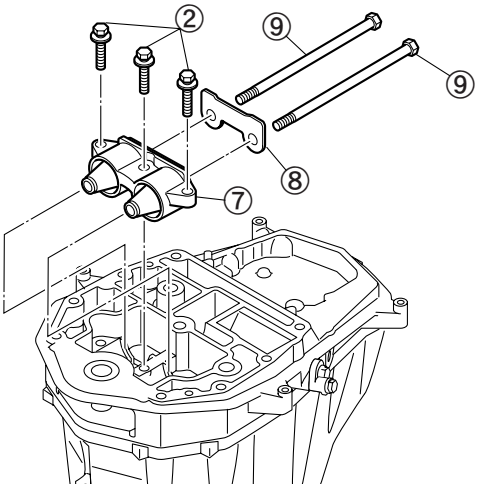
3. Loosen the upper mount bolts ② and the lower mount cover bolts (PORT and STBD) ③.



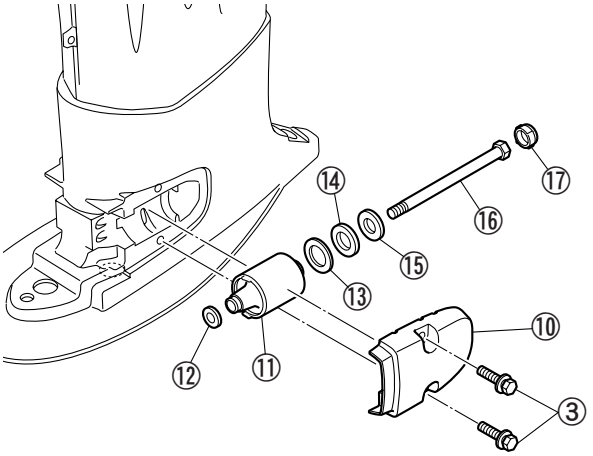
4. Remove the upper mounting nuts ④ and the lower mounting nuts ⑤, and then remove the upper case assembly ⑥.



5. Remove the upper mount bolts ②, the upper mount ⑦, the plate ⑧, and the upper mounting bolts ⑨.



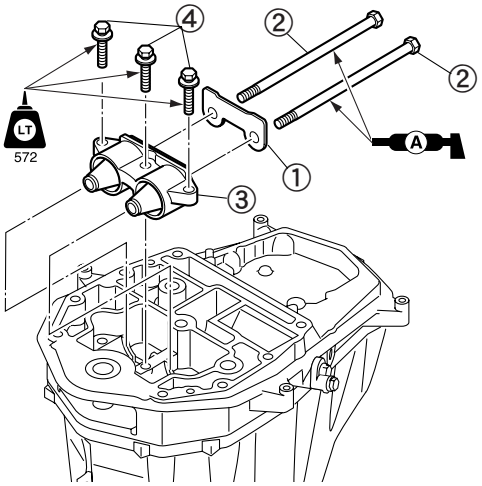
6. Remove the lower mount cover bolts ③, the covers ⑩, the lower mounts ⑪, the washers ⑫, ⑬, the rubber washers ⑭, the washers ⑮, the lower mounting bolts ⑯, and the caps ⑰.



Installing the upper case

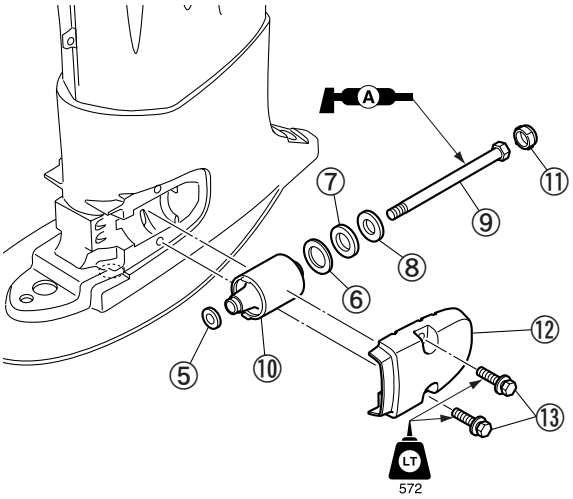
1. Install the plate ① and the upper mounting bolts ② to the upper mount ③, and then install the upper mount assembly.

2. Tighten the upper mount bolts ④ temporarily.



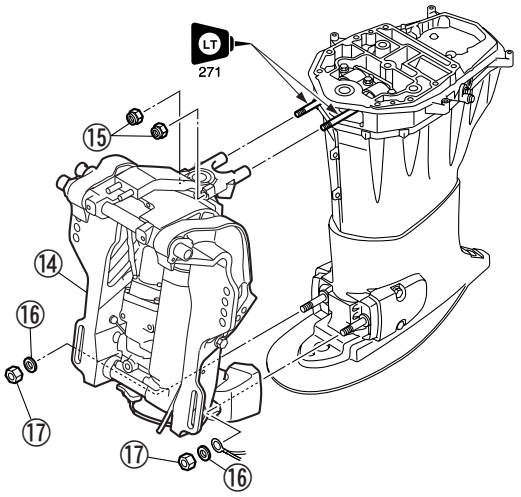
3. Install the washers ⑤, ⑥, the rubber washers ⑦, the washers ⑧, and the lower mounting bolts ⑨ to the lower mounts ⑩, and then install the caps ⑪, and the lower mount assemblies.

4. Install the lower mount covers ⑫, and then tighten the lower mount cover bolts ⑬ temporarily.



5. Install the upper and lower mounting bolts into the bracket assembly ⑭ simultaneously.

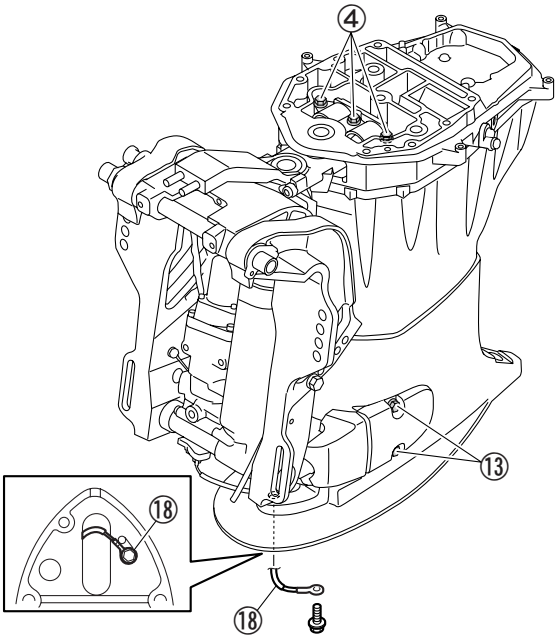
6. Install the upper mounting nuts ⑮, the washers ⑯, and the lower mounting nuts ⑰, and then tighten the upper mounting nuts ⑮ to the specified torque.



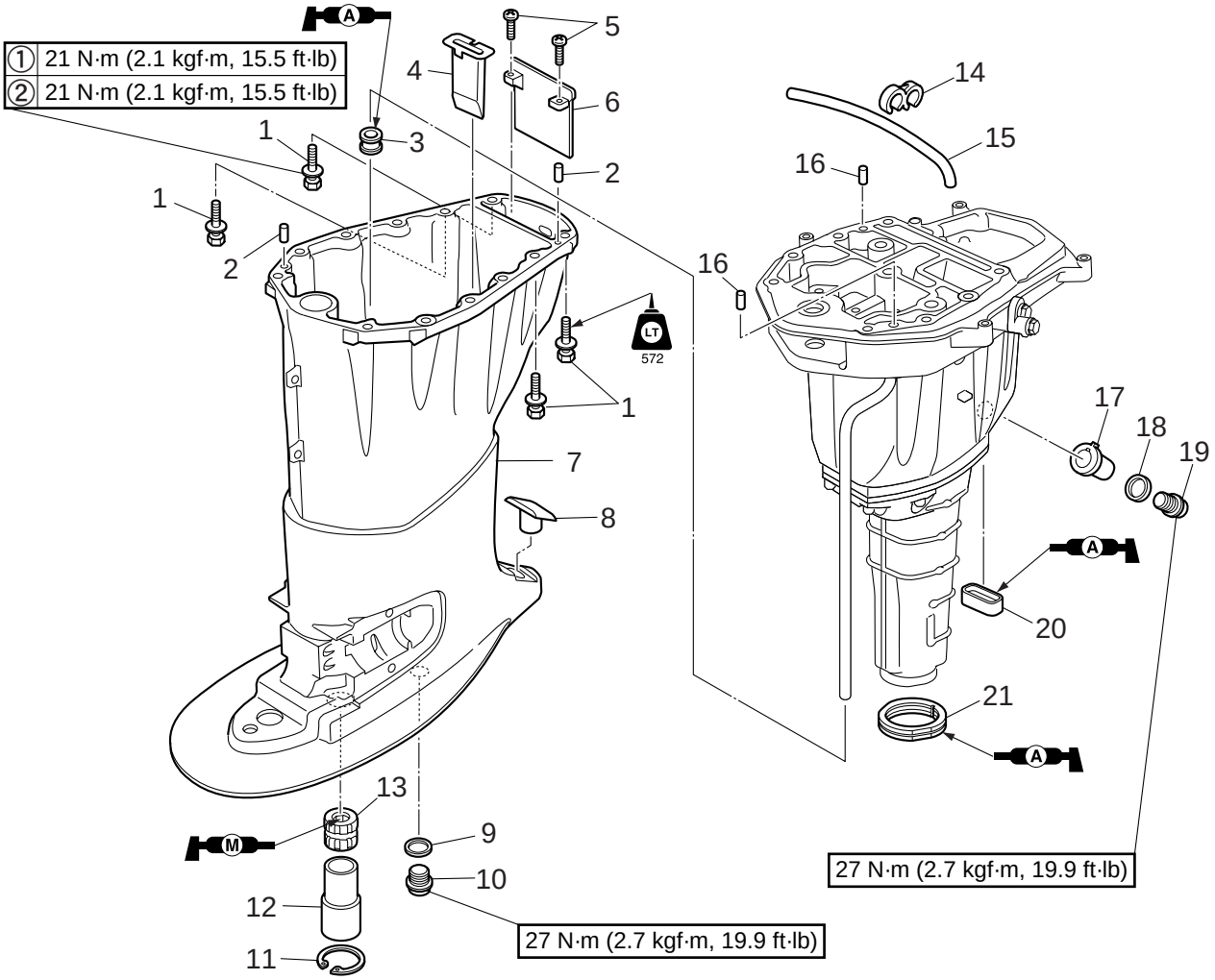
Upper mounting nut ⑮:
24 N·m (2.4 kgf·m, 17.7 ft·lb)

7. Tighten the upper mount bolts ④ and the lower mount cover bolts (PORT and STBD) ⑬.

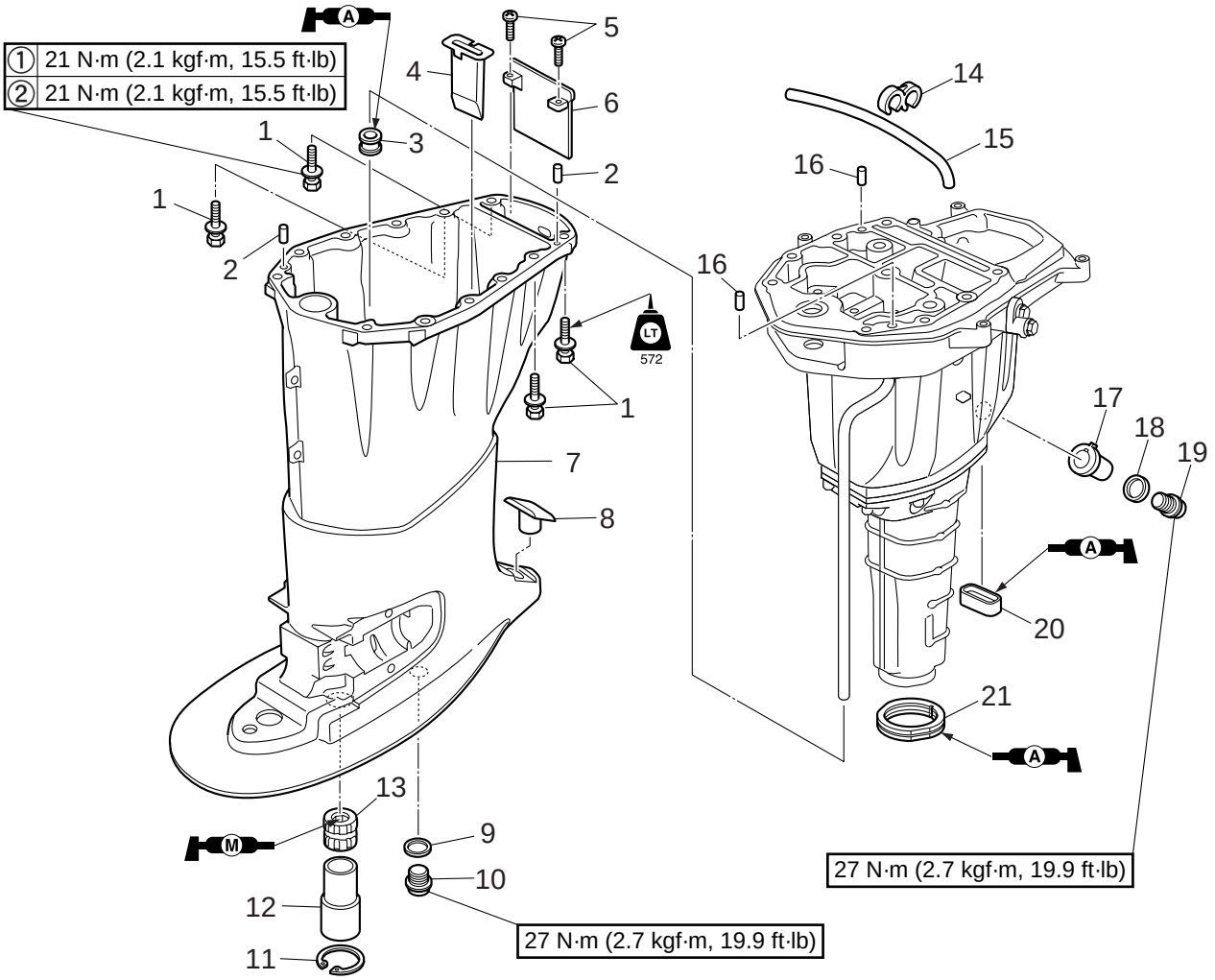
8. Install the ground lead ⑱.



Upper case



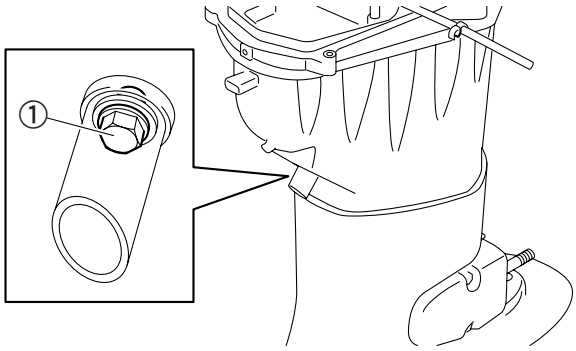
No.	Part name	Q'ty	Remarks
1	Bolt	4	M8 × 30 mm
2	Dowel	2	
3	Rubber seal	1	
4	Guide	1	
5	Screw	2	M5 × 16 mm
6	Baffle plate	1	
7	Upper case	1	
8	Grommet	1	
9	Gasket	1	**Not reusable** L-transom model
10	Plug	1	M14 × 12 mm, L-transom model
11	Circlip	1	L-transom model
12	Collar	1	L-transom model
13	Drive shaft bushing	1	L-transom model
14	Holder	1	
15	Hose	1	
16	Dowel	2	



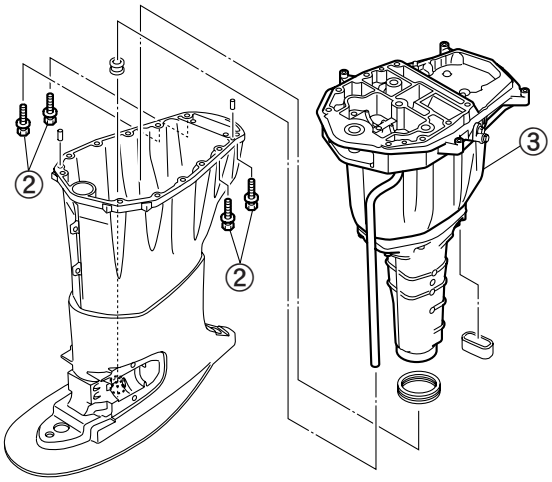
No.	Part name	Q'ty	Remarks
17	Damper	1	
18	Gasket	1	**Not reusable**
19	Drain bolt	1	
20	Rubber seal	1	
21	Rubber seal	1	**Not reusable**

Disassembling the upper case

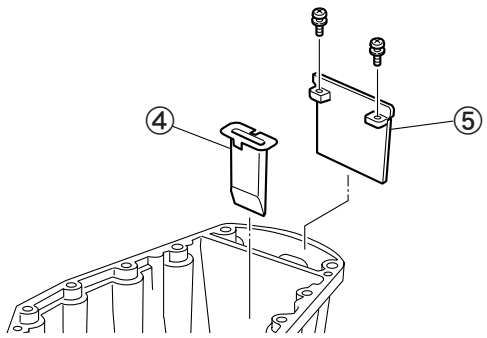
1. Remove the engine oil drain bolt ①.



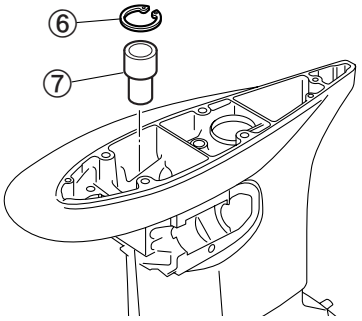
2. Remove the upper case bolts ②, and then remove the oil pan assembly ③ from the upper case.



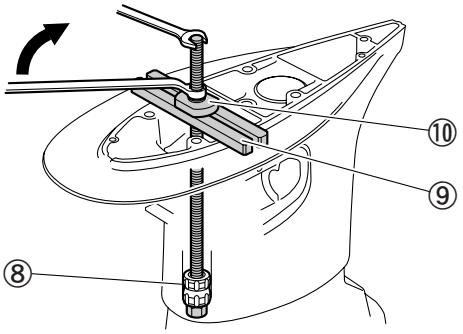
3. Remove the guide ④ and the baffle plate ⑤.



4. Remove the circlip ⑥ and the collar ⑦ (L-transom model).



5. Remove the drive shaft bushing ⑧ (L-transom model).



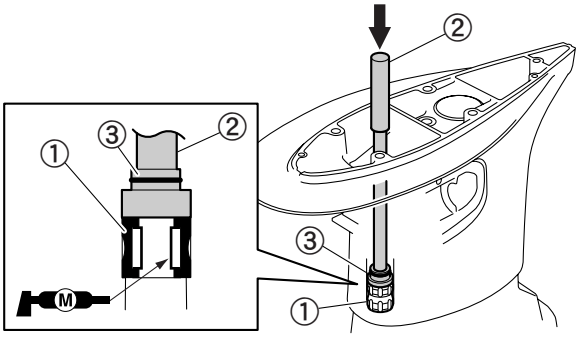
Stopper guide plate ⑨: 90890-06501
Bushing installer center bolt ⑩: 90890-06601

Checking the drive shaft bushing

1. Check the bushing. Replace if cracked or worn.

Assembling the upper case

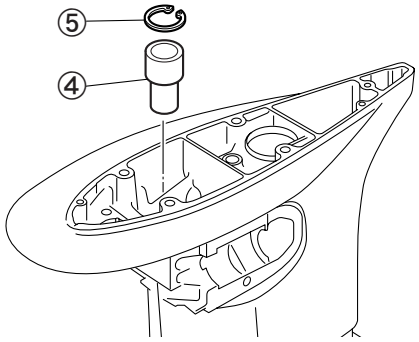
1. Install the drive shaft bushing ① into the upper case (L-transom model).



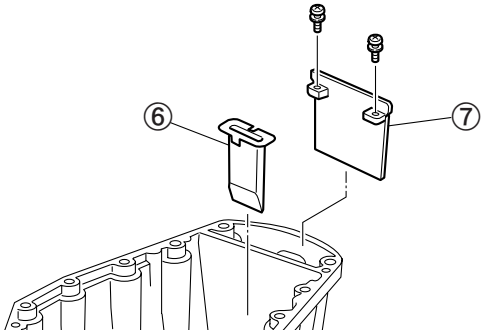
Driver rod L3 ②: 90890-06652
Needle bearing attachment ③: 90890-06614

9

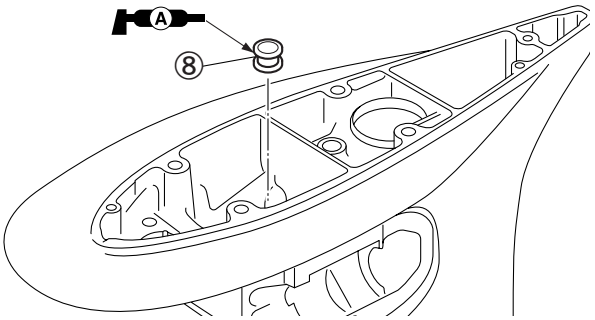
2. Install the collar ④ and the circlip ⑤ (L-transom model).



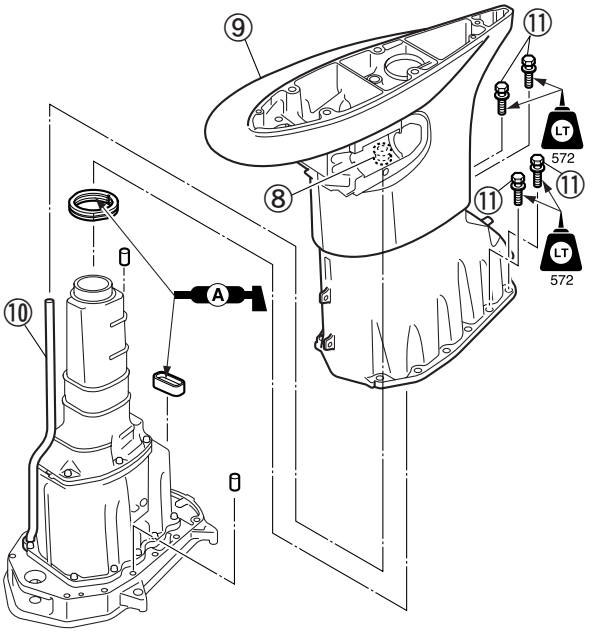
3. Install the guide ⑥ and the baffle plate ⑦.



4. Install a new rubber seal ⑧ into the upper case.

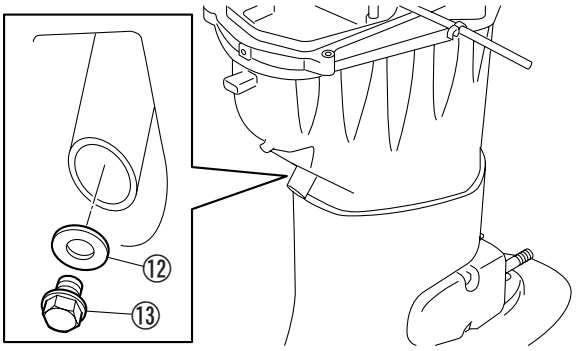


5. Install the upper case assembly ⑨ inserting the tip of the water pipe ⑩ into the rubber seal ⑧, and then tighten the upper case bolts ⑪ temporarily.



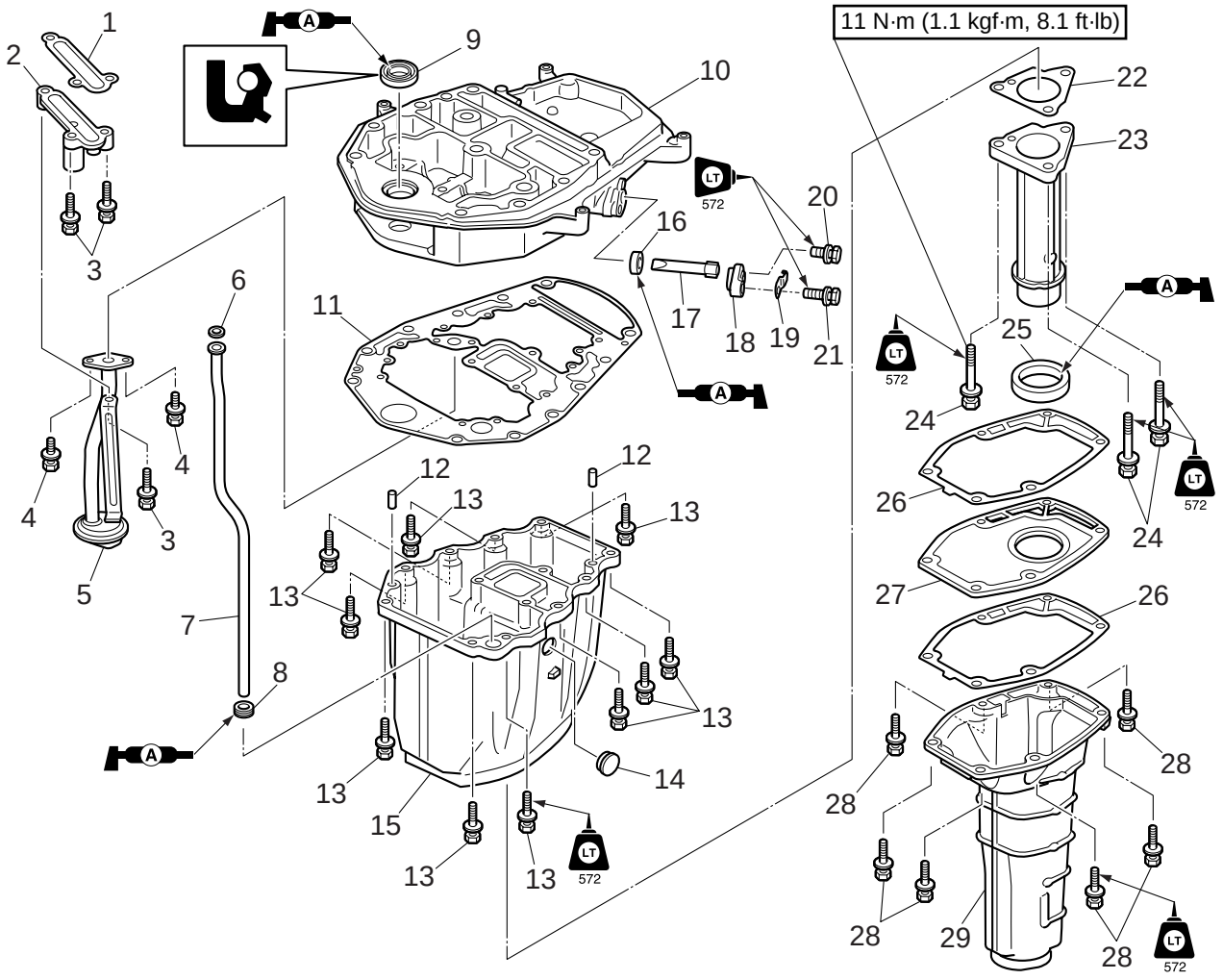
TIP:
When tightening the upper case bolts ⑪, tighten the power unit mounting bolts at the same time to the specified torque. See "Installing the power unit" (7-9) step 3 and step 4.

6. Install a new gasket ⑫ and the engine oil drain bolt ⑬, and then tighten the engine oil drain bolt ⑬ to the specified torque.

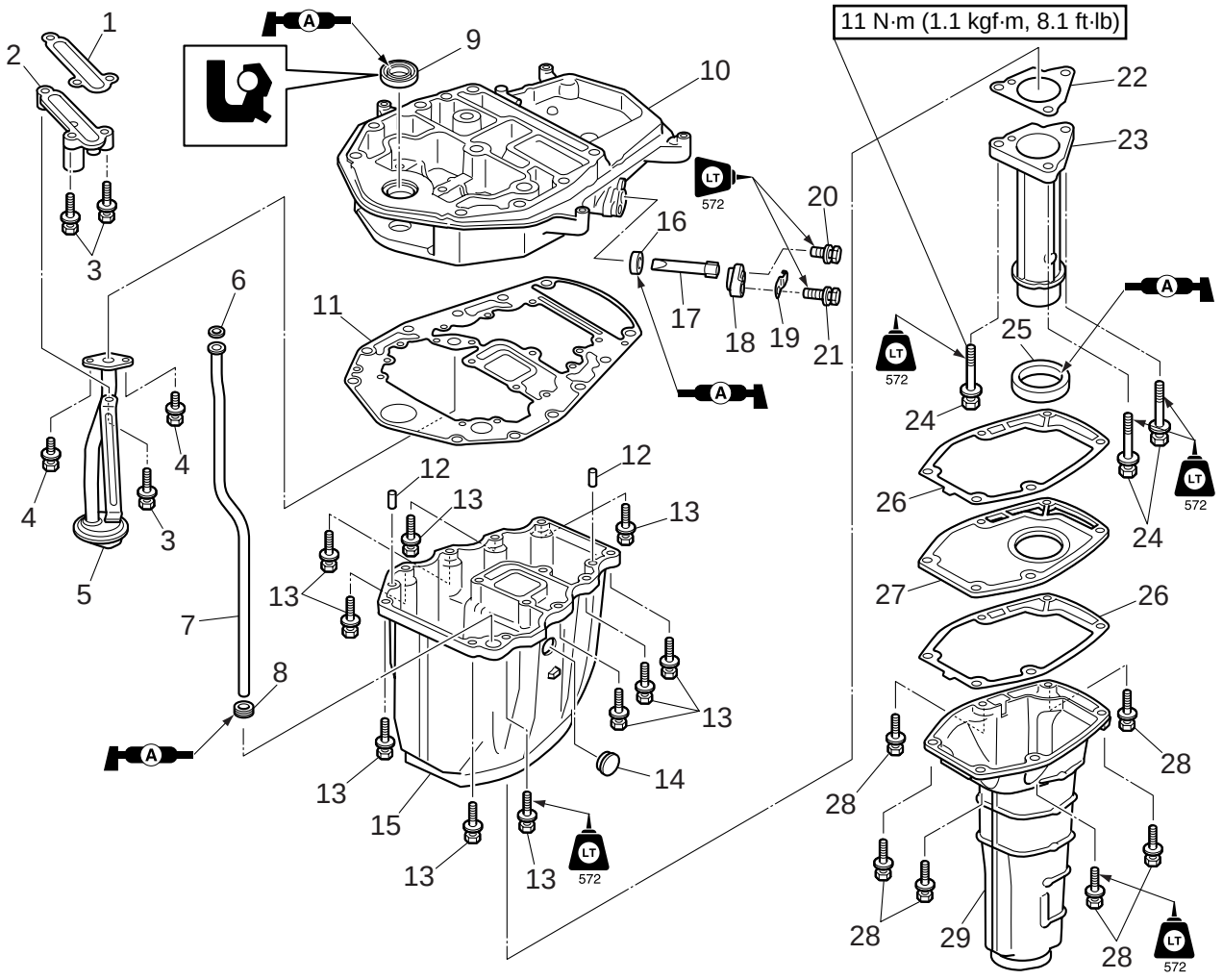


Engine oil drain bolt ⑬:
27 N·m (2.7 kgf·m, 19.9 ft·lb)

Exhaust manifold and oil pan



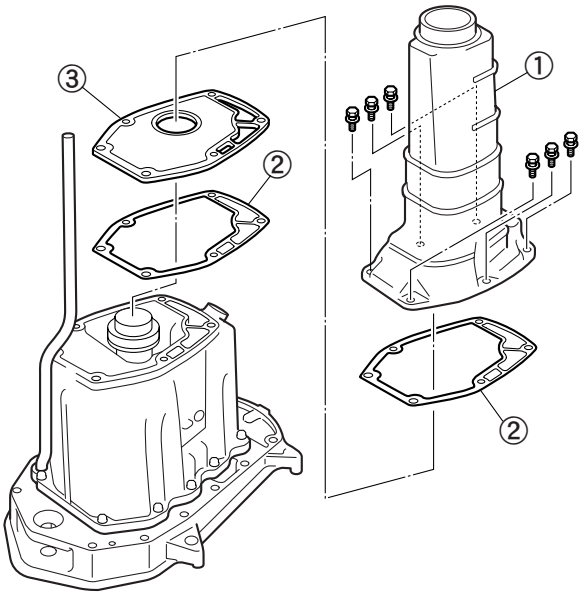
No.	Part name	Q'ty	Remarks
1	Gasket	1	**Not reusable**
2	Cover	1	
3	Bolt	3	M6 × 25 mm
4	Bolt	2	M6 × 16 mm
5	Oil strainer	1	
6	Gasket	1	
7	Pipe	1	
8	Rubber seal	1	**Not reusable**
9	Oil seal	1	**Not reusable**
10	Exhaust guide	1	
11	Gasket	1	**Not reusable**
12	Dowel	2	
13	Bolt	10	M6 × 25 mm
14	Grommet	1	
15	Oil pan	1	
16	Grommet	1	
17	Anode	1	



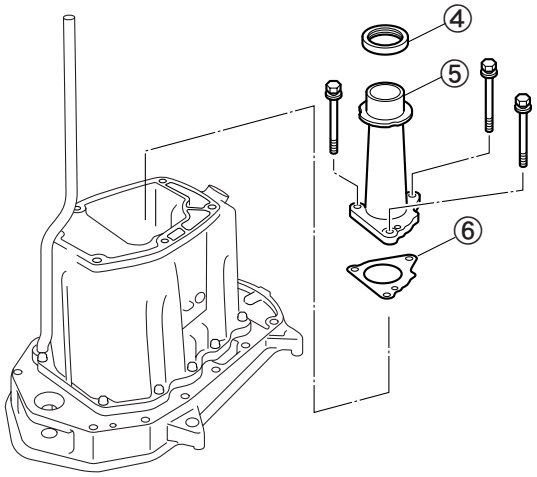
No.	Part name	Q'ty	Remarks
18	Cover	1	
19	Cover	1	
20	Bolt	1	M5 × 12 mm
21	Bolt	1	M6 × 20 mm
22	Gasket	1	**Not reusable**
23	Exhaust manifold	1	
24	Bolt	3	M6 × 50 mm
25	Gasket	1	**Not reusable**
26	Gasket	2	**Not reusable**
27	Plate	1	
28	Bolt	6	M6 × 25 mm
29	Muffler	1	

Disassembling the oil pan and exhaust manifold

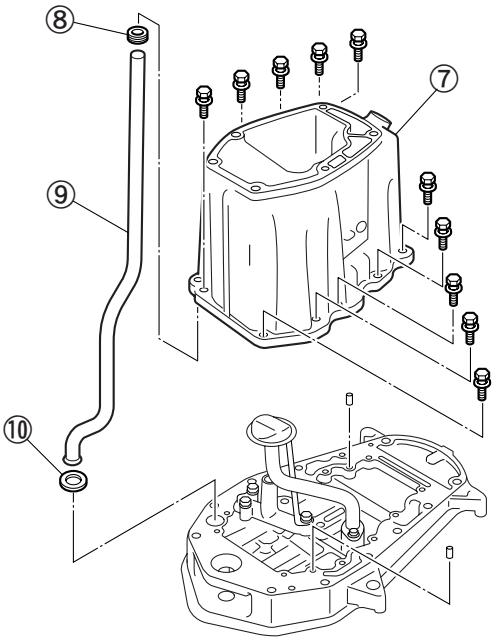
1. Remove the muffler ①, the gaskets ②, and the plate ③.



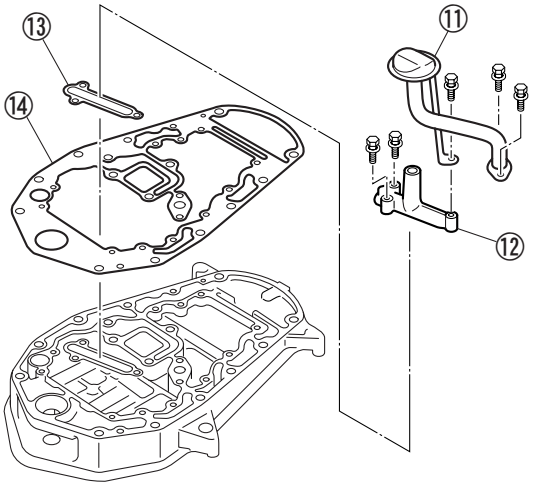
2. Remove the rubber seal ④, the exhaust manifold ⑤, and the gasket ⑥.



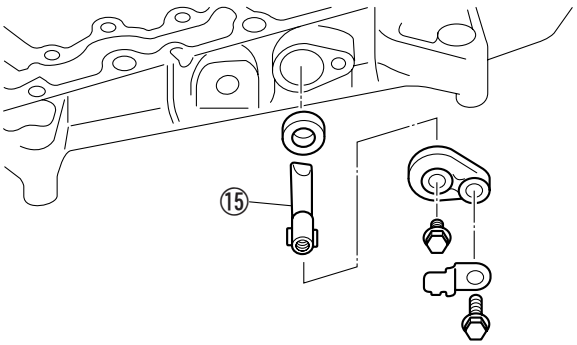
3. Remove the oil pan ⑦, the rubber seal ⑧, the cooling water pipe ⑨, and the gasket ⑩,



4. Remove the oil strainer ⑪, the relief valve ⑫, and the gaskets ⑬ and ⑭.

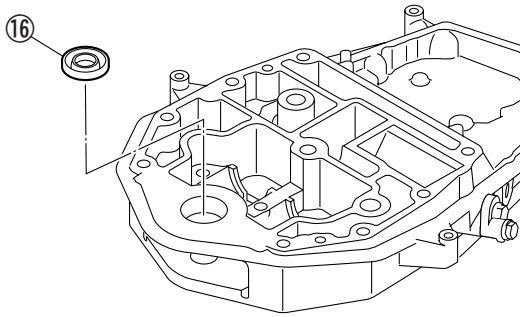


5. Remove the anode ⑮.



9

6. Remove the oil seal ⑯.



Checking the oil pan and exhaust manifold

1. Clean the removed parts.
2. Check the exhaust guide, the exhaust manifold, and the muffler. Replace if corroded or cracked.
3. Check the oil pan. Replace if corroded or cracked.

Checking the oil strainer

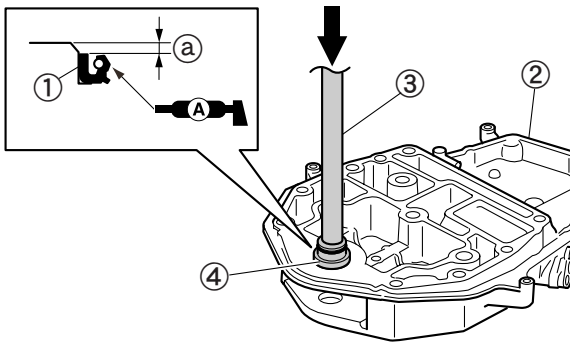
1. Check the oil strainer. Clean if there is dirt or residues.

Checking the exhaust guide anode

1. Check the anode. Clean if there is grease, oil, or scales. ***NOTICE:*** **Do not grease, oil, or paint the anode.**

Assembling the oil pan and exhaust manifold

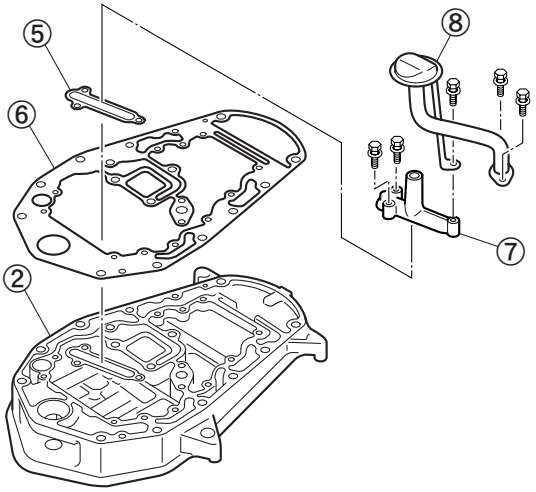
1. Install a new oil seal ① into the exhaust guide ② to the specified depth ⓐ.



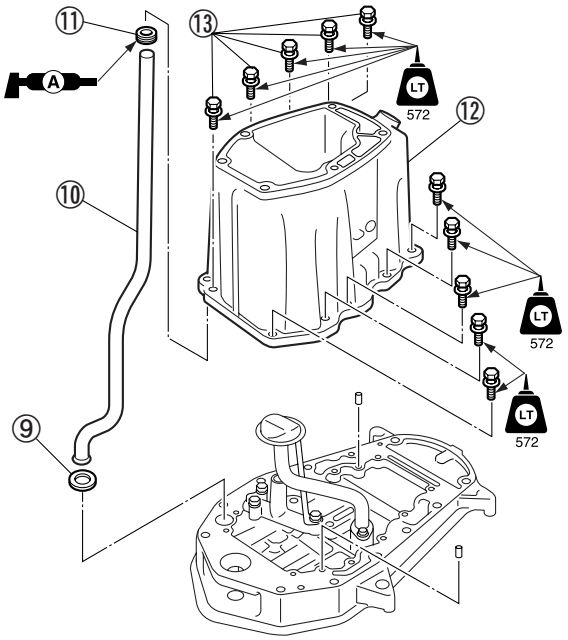
Driver rod L3 ③: 90890-06652
Needle bearing attachment ④:
90890-06613

Installation depth ⓐ:
0.5–1.0 mm (0.02–0.04 in)

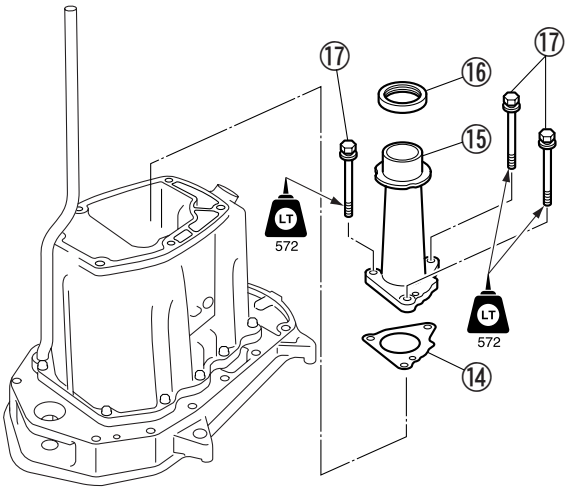
2. Install new gaskets ⑤ and ⑥ onto the exhaust guide ②.
3. Install the relief valve ⑦ and the oil strainer ⑧.

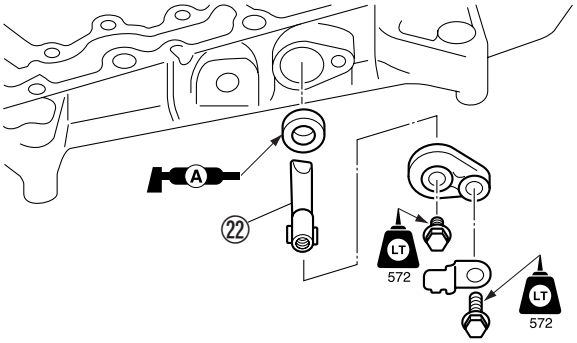


4. Install the gasket ⑨, the cooling water pipe ⑩, a new rubber seal ⑪, and the oil pan ⑫, and then tighten the oil pan bolts ⑬ temporarily.



5. Install a new gasket ⑭, the exhaust manifold ⑮, and the rubber seal ⑯, and then tighten the exhaust manifold bolts ⑰ temporarily.

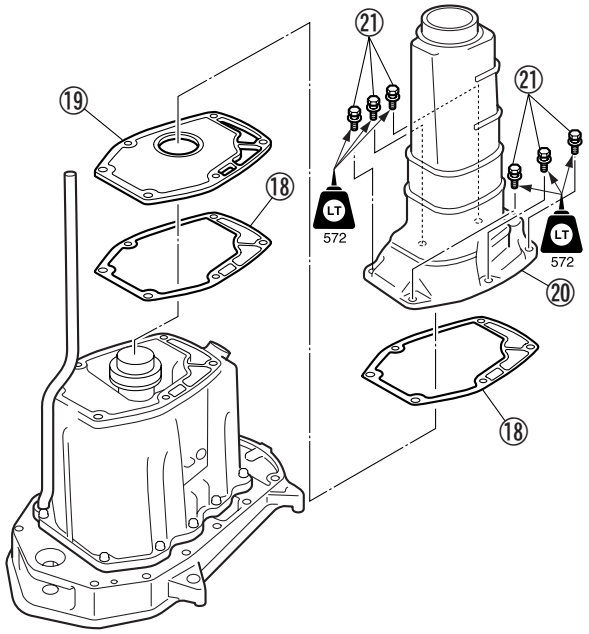




6. Tighten the exhaust manifold bolts ⑰ to the specified torque, and then tighten the oil pan bolts ⑬.

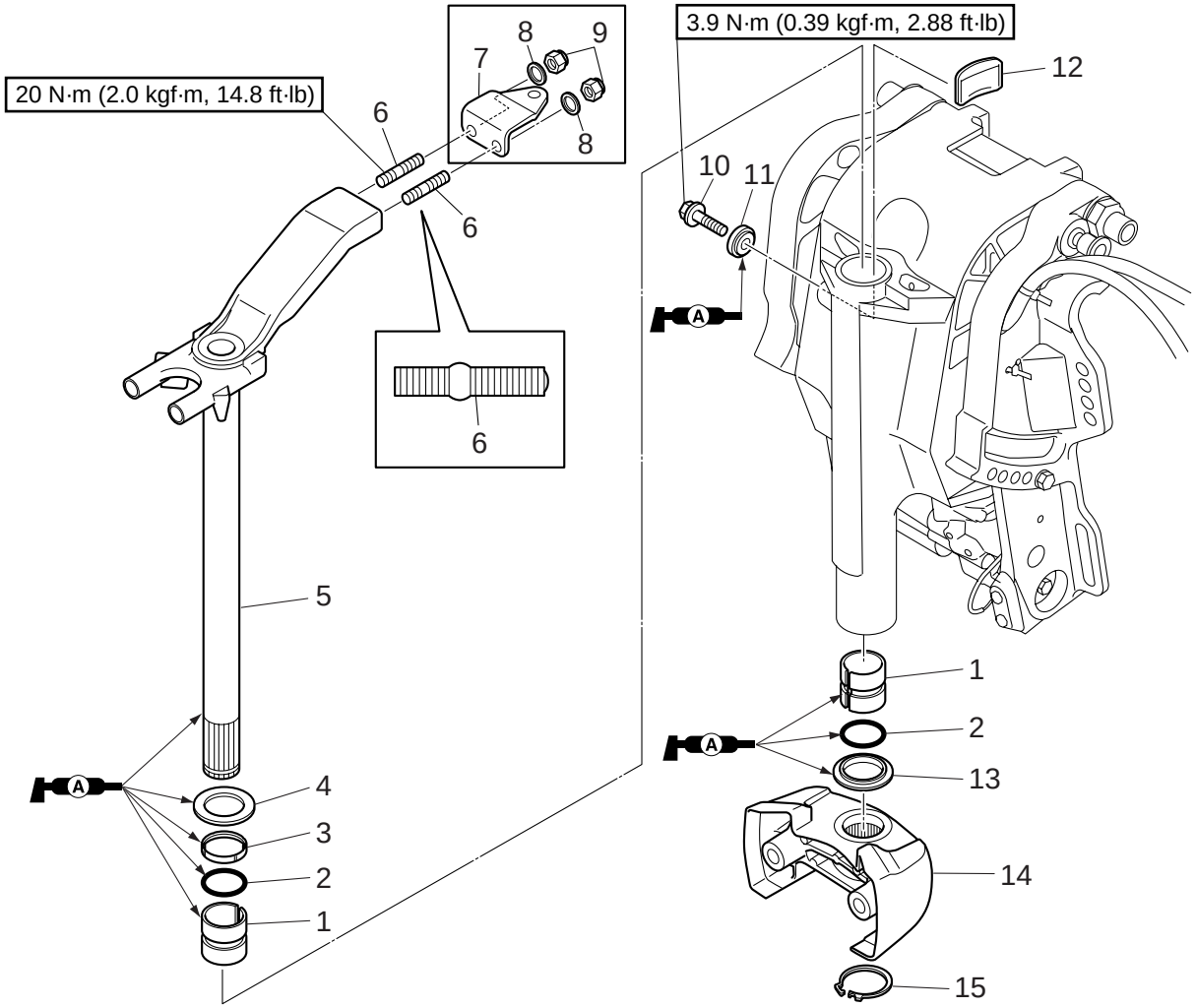
Exhaust manifold bolt ⑰:
11 N·m (1.1 kgf·m, 8.1 ft·lb)

7. Install new gaskets ⑱, the plate ⑲, and the muffler ⑳, and then tighten the bolts ㉑.



8. Install the anode ㉒.

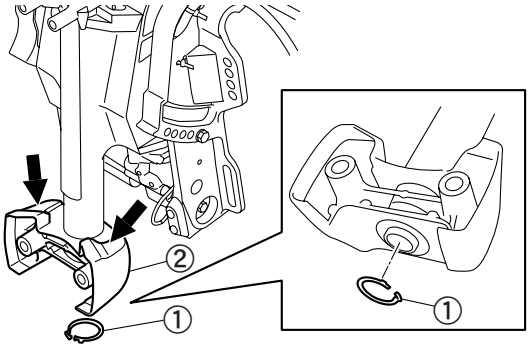
Steering arm



No.	Part name	Q'ty	Remarks
1	Bushing	2	
2	O-ring	2	**Not reusable**
3	Bushing	1	
4	Washer	1	
5	Steering arm	1	
6	Stud bolt	2	
7	Steering hook	1	Remote control model
8	Washer	2	Remote control model
9	Self-locking nut	2	Remote control model
10	Bolt	1	M6 × 22 mm
11	Grommet	1	
12	Friction piece	1	
13	Bushing	1	
14	Steering yoke	1	
15	Circlip	1	

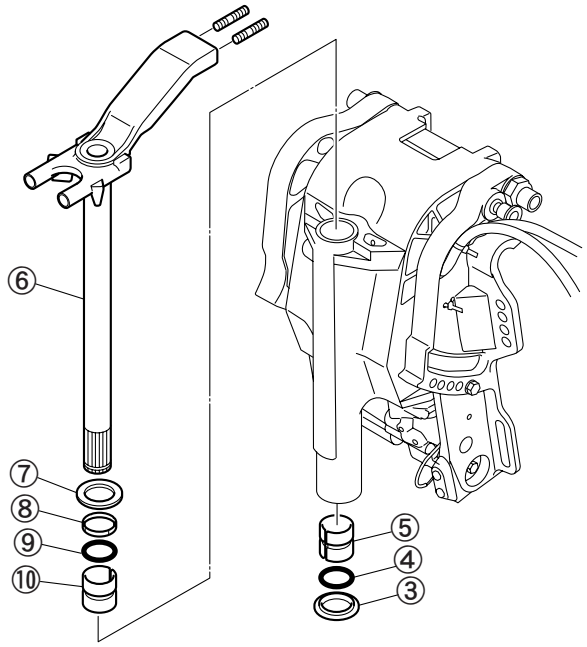
Removing the steering arm

1. Remove the circlip ①, and then remove the steering yoke ② by striking it with a copper hammer.

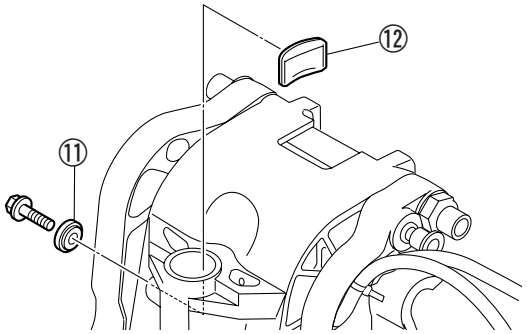


2. Remove the bushing ③, the O-ring ④, and the bushing ⑤.

3. Remove the steering arm ⑥, the washer ⑦, the bushing ⑧, the O-ring ⑨, and the bushing ⑩.

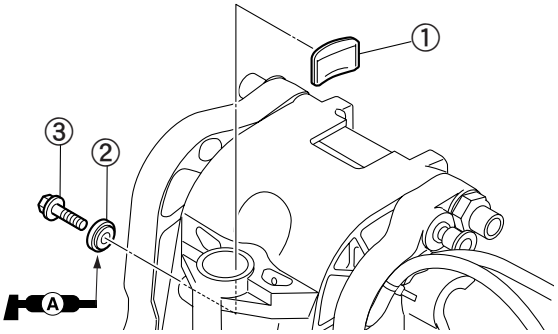


4. Remove the rubber seal ⑪ and the friction piece ⑫.



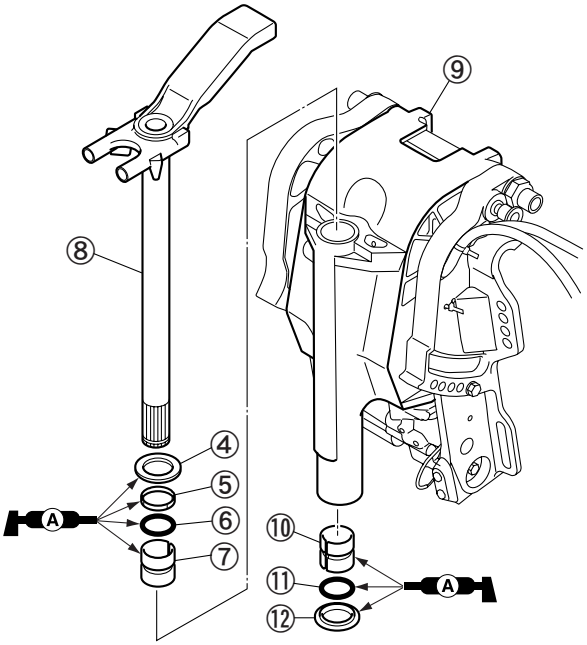
Installing the steering arm

1. Install the friction piece ① and the rubber seal ②, and then tighten the friction piece bolt ③ temporarily.



2. Install the washer ④, the bushing ⑤, a new O-ring ⑥, and the bushing ⑦ onto the steering arm ⑧, and then install the steering arm to the swivel bracket ⑨.

3. Install the bushing ⑩, a new O-ring ⑪, and the bushing ⑫.



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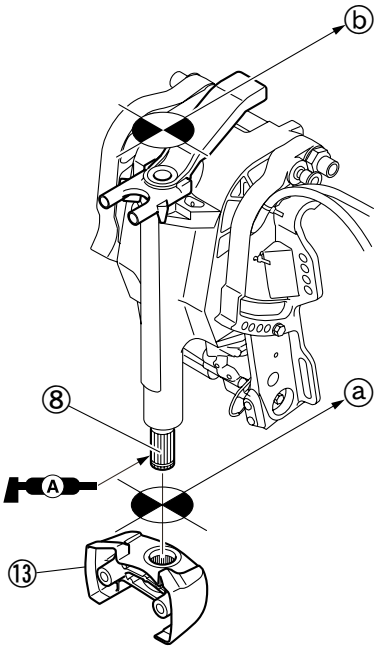
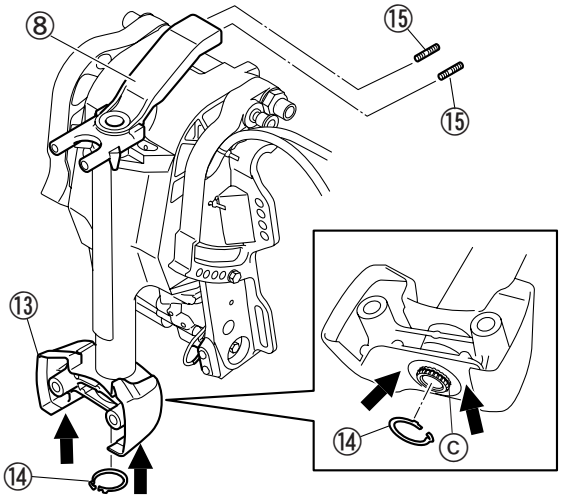
4. Install the steering yoke ⑬, making sure that it is facing the same direction as the steering arm ⑧ (aligning ⓐ with ⓑ).



5. Hold the steering arm ⑧, and then strike the steering yoke ⑬ with a copper hammer until the groove ⓒ for installing the circlip is visible.

6. Install the circlip ⑭.

7. Install the steering arm stud bolts ⑮, and then tighten them to the specified torque.

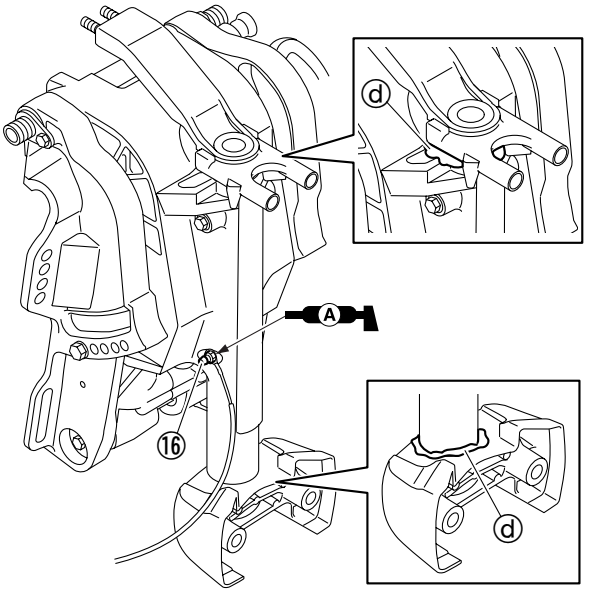


Steering arm stud bolt ⑮:
20 N·m (2.0 kgf·m, 14.8 ft·lb)

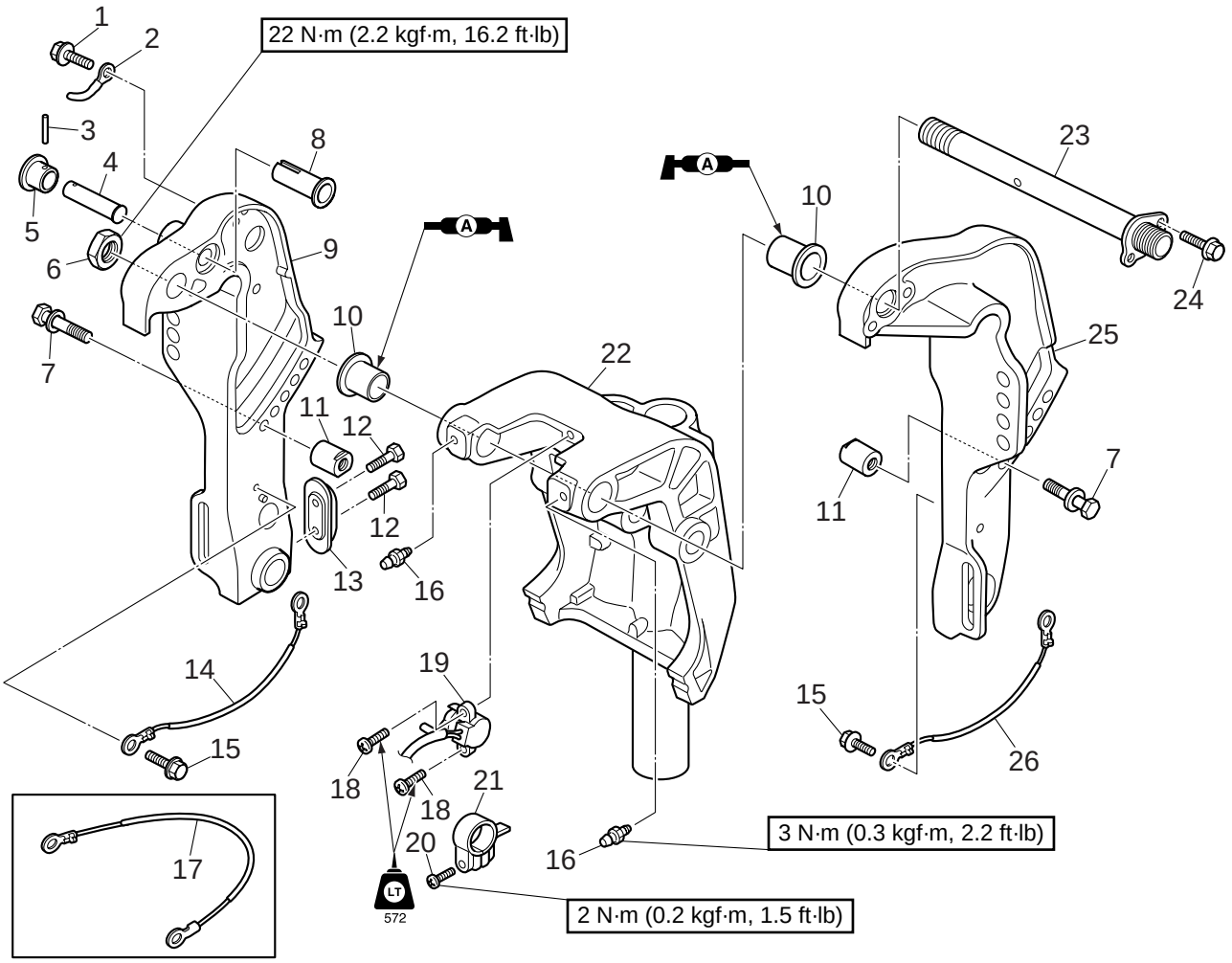
8. Tighten the friction piece bolt to the specified torque.

Friction piece bolt:
3.9 N·m (0.39 kgf·m, 2.88 ft·lb)

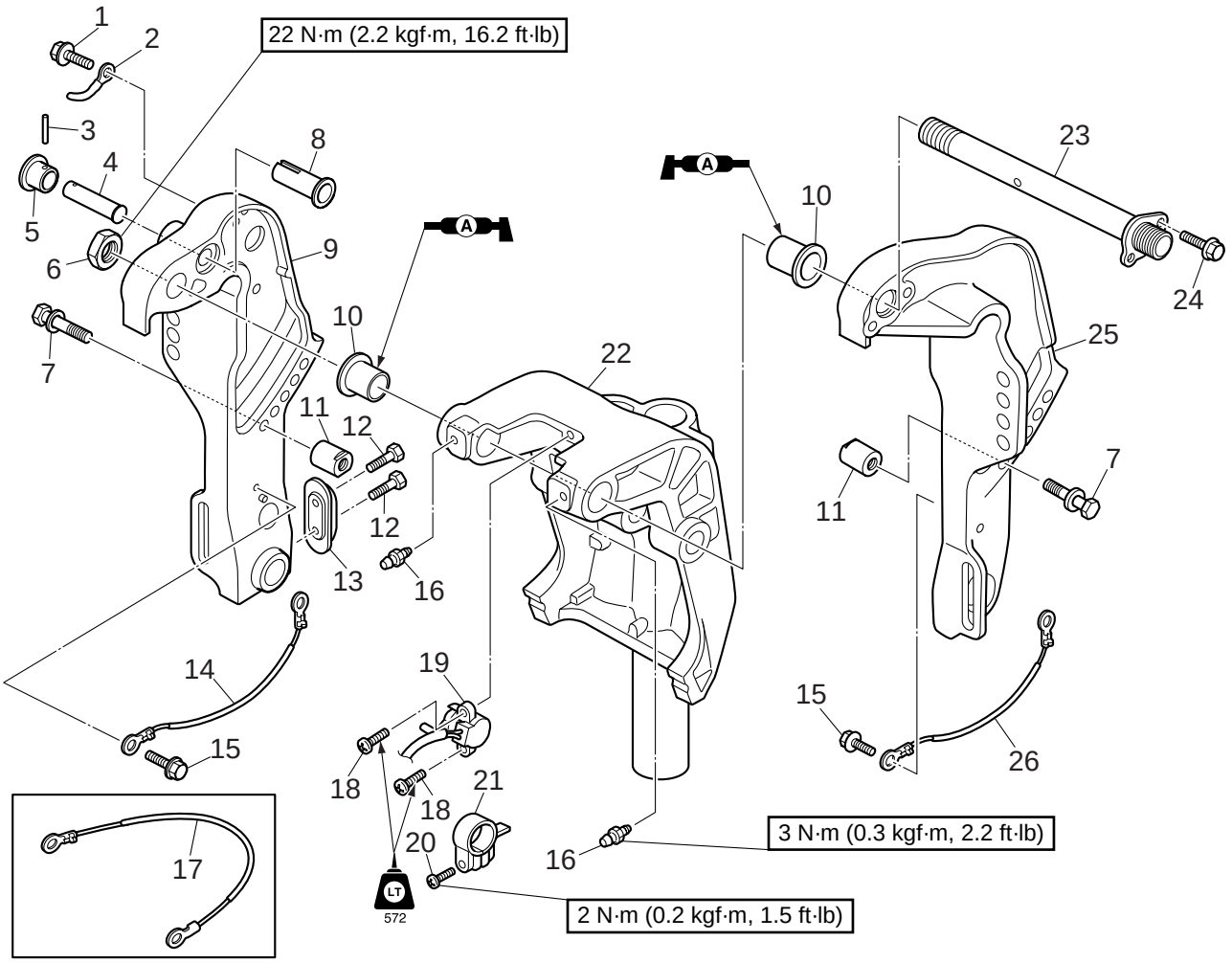
9. Apply grease into the grease nipple ⑯ until it comes out from both the upper and lower bushings ⓓ.



Clamp bracket and swivel bracket



No.	Part name	Q'ty	Remarks
1	Bolt	1	M6 × 14 mm, Remote control model with PTT
2	Holder	1	Remote control model with PTT
3	Pin	1	
4	Stopper shaft	1	
5	Stopper knob	1	
6	Self-locking nut	1	
7	Bolt	2	M10 × 50 mm
8	Bushing	1	
9	Clamp bracket (STBD)	1	
10	Bushing	2	
11	Stopper	2	
12	Bolt	2	M6 × 25 mm
13	Anode	1	
14	Ground lead	1	PTT model
15	Bolt	2	M6 × 14 mm, PTT model
16	Grease nipple	2	Remote control model
17	Ground lead	1	Hydro tilt model



No.	Part name	Q'ty	Remarks
18	Screw	2	M6 × 15 mm, Remote control model with PTT
19	Trim sensor	1	Remote control model with PTT
20	Screw	1	M6 × 24 mm, Remote control model with PTT
21	Trim sensor cam	1	Remote control model with PTT
22	Swivel bracket	1	
23	Through tube	1	
24	Bolt	1	M8 × 20 mm
25	Clamp bracket (PORT)	1	
26	Ground lead	1	PTT model

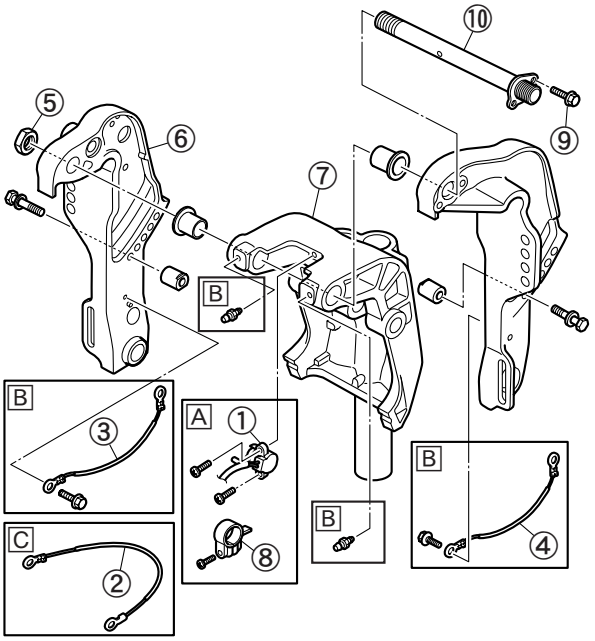
Removing the clamp bracket

1. Remove the trim sensor ① (remote control model with PTT).

2. Remove the ground lead ② (hydro tilt model).
   Remove the ground leads ③ and ④ (PTT model).

3. Remove the self-locking nut ⑤.

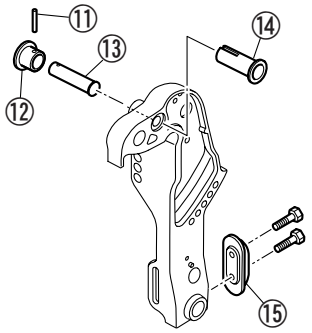
4. Remove the clamp the bracket (STBD) ⑥, the swivel bracket ⑦, and the trim sensor cam ⑧ (remote control model with PTT), and then remove the bolt ⑨ and the through tube ⑩.



A Remote control model with PTT
B PTT model
C Hydro tilt model

5. Remove the pin ⑪, the stopper knob ⑫, the stopper shaft ⑬, and the bushing ⑭.

6. Remove the anode ⑮.



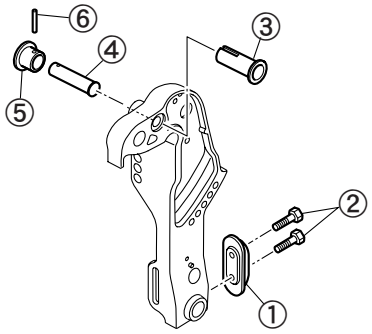
Checking the clamp bracket anode

1. Check the anode. Clean if there is grease, oil, or scales. ***NOTICE:*** **Do not oil, grease, or paint the anode.**

Installing the clamp bracket

1. Install the anode ①, and then tighten the anode bolt ②.

2. Install the bushing ③, the stopper shaft ④, the stopper knob ⑤, and the pin ⑥.



3. Install the trim sensor ⑦ to the swivel bracket ⑧ (remote control model with PTT).

4. Install the through tube ⑨ and the bolt ⑩ to the clamp bracket (PORT) ⑪.

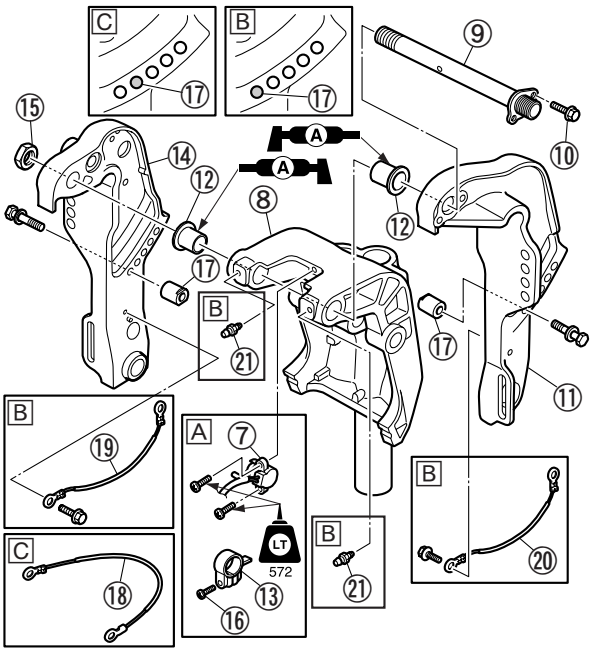
5. Install the bushings ⑫ to the swivel bracket ⑧.

6. Install the swivel bracket ⑧, the trim sensor cam ⑬ (remote control model with PTT), and the clamp bracket (STBD) ⑭, and then tighten the self-locking nut ⑮ and the trim sensor cam screw ⑯ (remote control model with PTT) to the specified torque.

7. Install the stoppers ⑰.

8. Install the ground lead ⑱ (hydro tilt model).
   Install the ground leads ⑲ and ⑳ (PTT model).

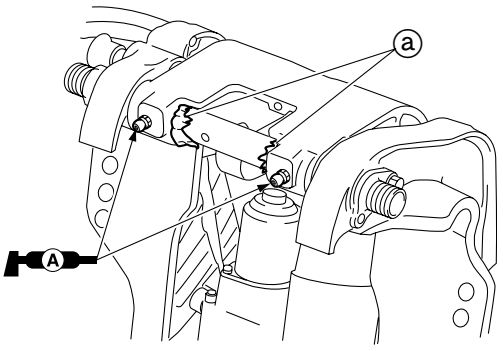
9. Install the grease nipples ㉑, and then tighten them to the specified torque (remote control model).



A Remote control model with PTT
B PTT model
C Hydro tilt model

Self-locking nut ⑮: 22 N·m (2.2 kgf·m, 16.2 ft·lb) Trim sensor cam screw ⑯: 2 N·m (0.2 kgf·m, 1.5 ft·lb) Grease nipple ㉑: 3 N·m (0.3 kgf·m, 2.2 ft·lb)

10. Apply grease into the grease nipples until grease comes out from the bushings ⓐ (remote control model).

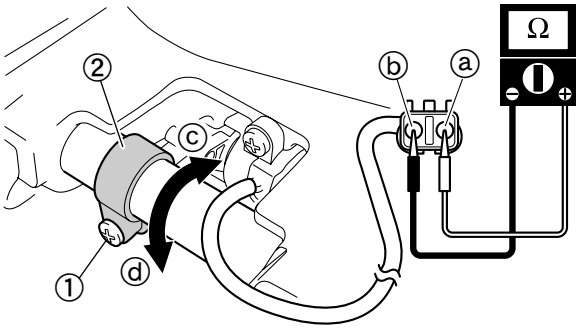


Adjusting the trim sensor cam (remote control model with PTT)

1. Tilt the outboard motor to the fully down position.

2. Loosen the trim sensor cam screw ①.

3. Adjust the trim sensor cam ② so that the trim sensor setting resistance is within specification.



Digital circuit tester: 90890-03174

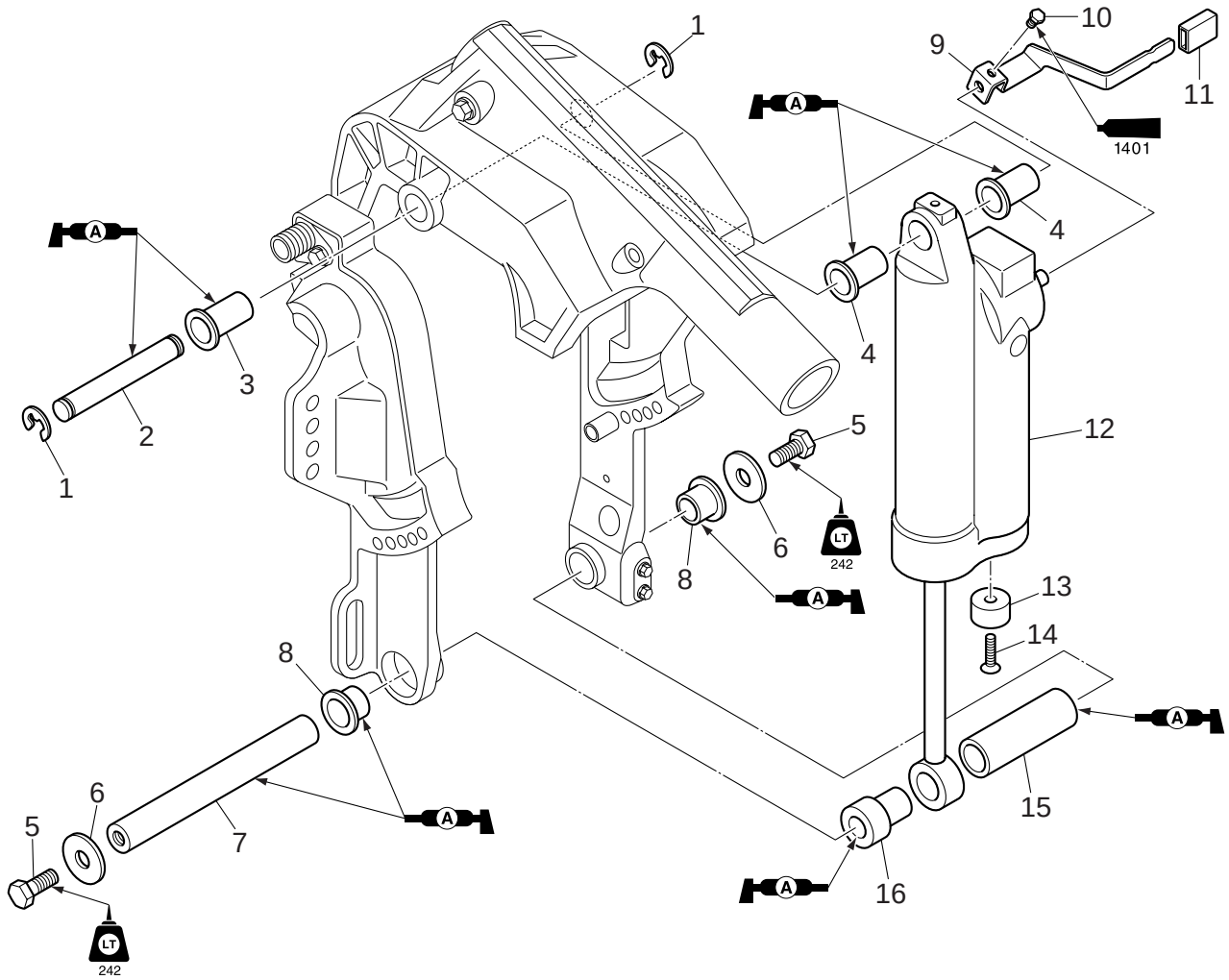
Trim sensor setting resistance: Terminal ⓐ–Terminal ⓑ 9.0–11.0 Ω

TIP:
- To decrease the resistance, turn the trim sensor cam in direction ⓒ.
- To increase the resistance, turn the trim sensor cam in direction ⓓ.

4. Tighten the trim sensor cam screw ① to the specified torque.

Trim sensor cam screw ①: 2 N·m (0.2 kgf·m, 1.5 ft·lb)

Hydro tilt



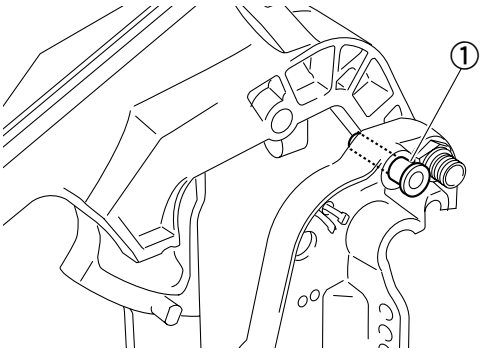
No.	Part name	Q'ty	Remarks
1	E-clip	2	
2	Shaft	1	
3	Bushing	1	
4	Bushing	2	
5	Bolt	2	M8 × 15 mm
6	Washer	2	
7	Shaft	1	
8	Bushing	2	
9	Tilt lock lever	1	
10	Bolt	1	M6 × 10 mm
11	Cap	1	
12	Hydro tilt assembly	1	
13	Anode	1	
14	Screw	1	M6 × 25 mm
15	Collar	1	
16	Collar	1	

Removing the hydro tilt assembly

⚠ WARNING

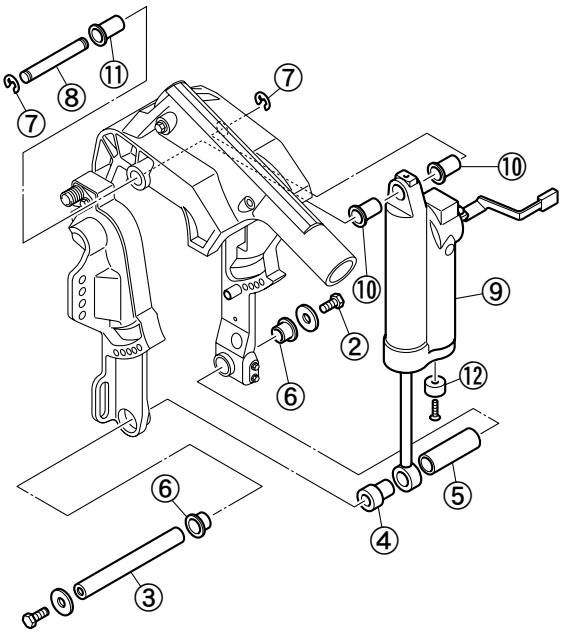
When removing the hydro tilt assembly with the power unit installed, make sure to suspend the outboard motor.

1. Tilt the swivel bracket to the fully up position, and then support it with the tilt stop lever ①.



2. Remove the hydro tilt bolt ②, the lower mount shaft ③, the collars ④, ⑤, and the bushings ⑥.

3. Remove the E-clips ⑦, the upper mount shaft ⑧, the hydro tilt assembly ⑨, the bushings ⑩, ⑪, and the anode ⑫.



Checking the hydro tilt

1. Check the hydro tilt unit. Replace if there is gas leakage, oil leakage, or damage, or if the rod is bent. **WARNING! Do not disassemble the hydro tilt.**

Checking the hydro tilt anode

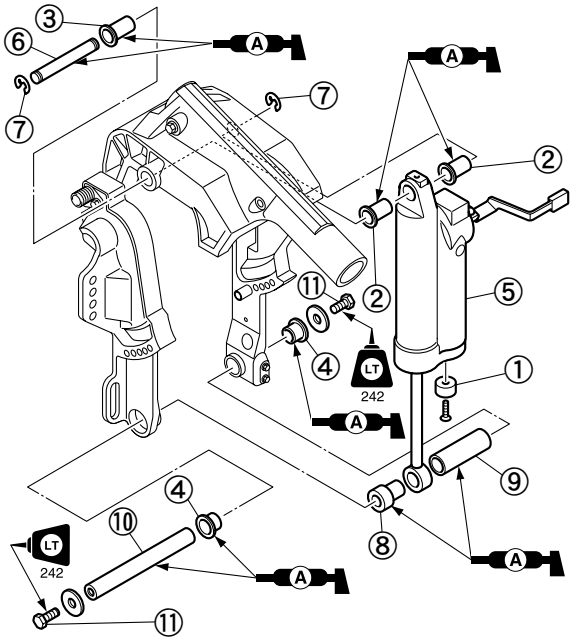
1. Check the anode. Clean if there is grease, oil, or scales. ***NOTICE:*** **Do not grease, oil, or paint the anode.**

Installing the hydro tilt assembly

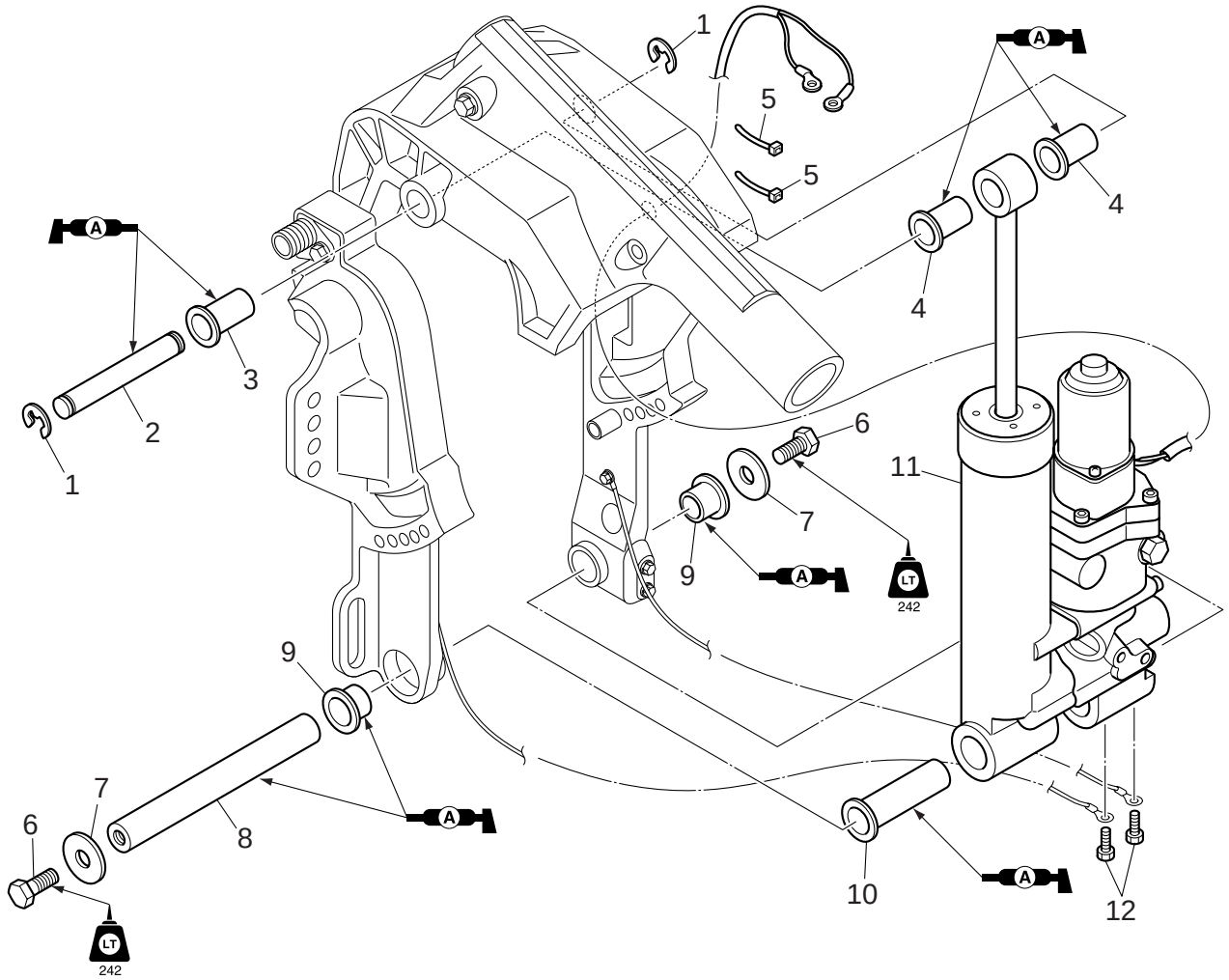
1. Install the anode ①, the bushings ②, ③ and ④.

2. Install the hydro tilt assembly ⑤, the upper mount shaft ⑥, and the E-clips ⑦.

3. Install the collars ⑧, ⑨, and the lower mount shaft ⑩, and then tighten the hydro tilt bolts ⑪.



PTT unit



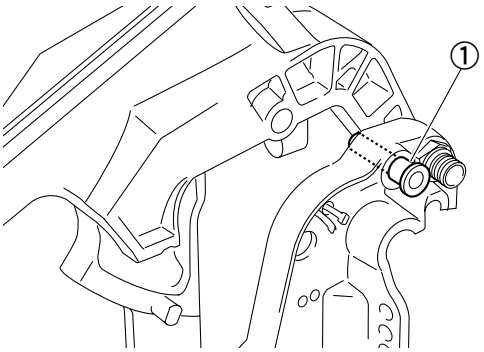
No.	Part name	Q'ty	Remarks
1	E-clip	2	
2	Shaft	1	
3	Bushing	1	
4	Bushing	2	
5	Plastic tie	2	**Not reusable**
6	Bolt	2	M8 × 15 mm
7	Washer	2	
8	Shaft	1	
9	Bushing	2	
10	Bushing	1	
11	PTT unit	1	
12	Bolt	2	M6 × 10 mm

Removing the PTT unit

⚠ WARNING

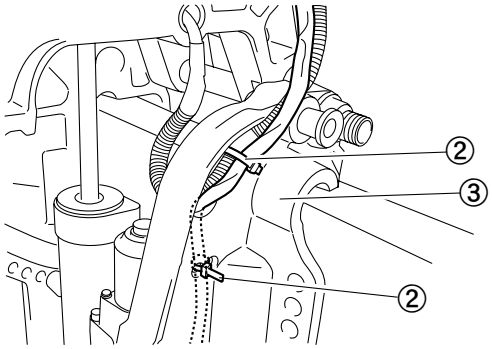
When removing the PTT unit with the power unit installed, make sure to suspend the outboard motor.

1. Tilt the swivel bracket to the fully up position, and then support it with the tilt stop lever ①.



2. Remove the plastic ties, and then remove the corrugated tube.

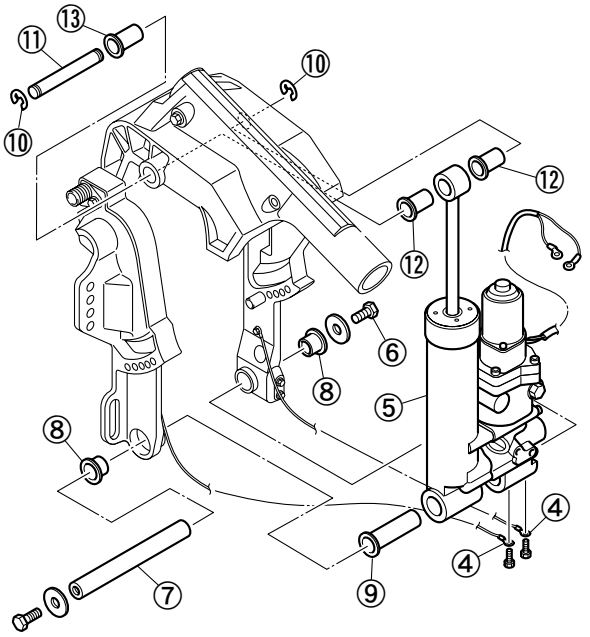
3. Remove the plastic ties ② from the clamp bracket (STBD) ③.



4. Remove the ground leads ④ from the PTT unit ⑤.

5. Remove the PTT unit bolt ⑥, the lower mount shaft ⑦, and the bushings ⑧ and ⑨.

6. Remove the E-clips ⑩, the upper mount shaft ⑪, the PTT unit ⑤, and the bushings ⑫ and ⑬.



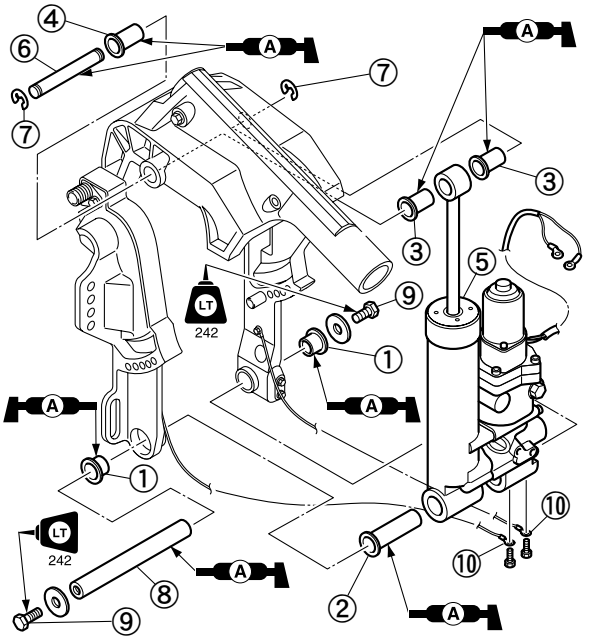
Installing the PTT unit

1. Install the bushings ①, ②, ③ and ④.

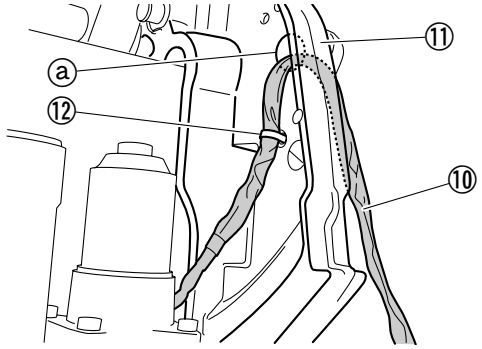
2. Install the PTT unit ⑤, the upper mount shaft ⑥, and the E-clips ⑦.

3. Install the lower mount shaft ⑧, and then tighten the PTT unit bolts ⑨.

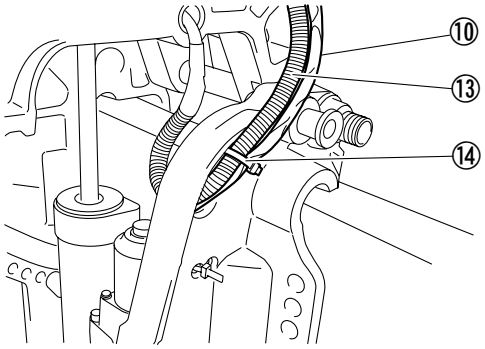
4. Install the ground leads ⑩.



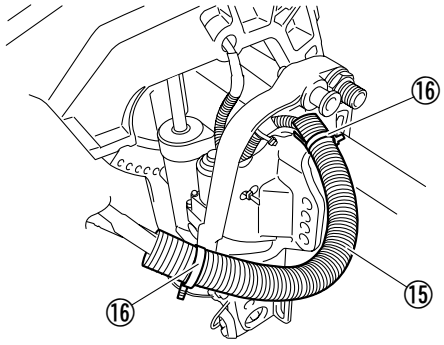
5. Pass the PTT motor lead ⑩ through the hole ⓐ in the clamp bracket ⑪ (STBD), and then fasten the PTT motor lead ⑩ to the clamp bracket ⑪ (STBD) with a plastic tie ⑫.



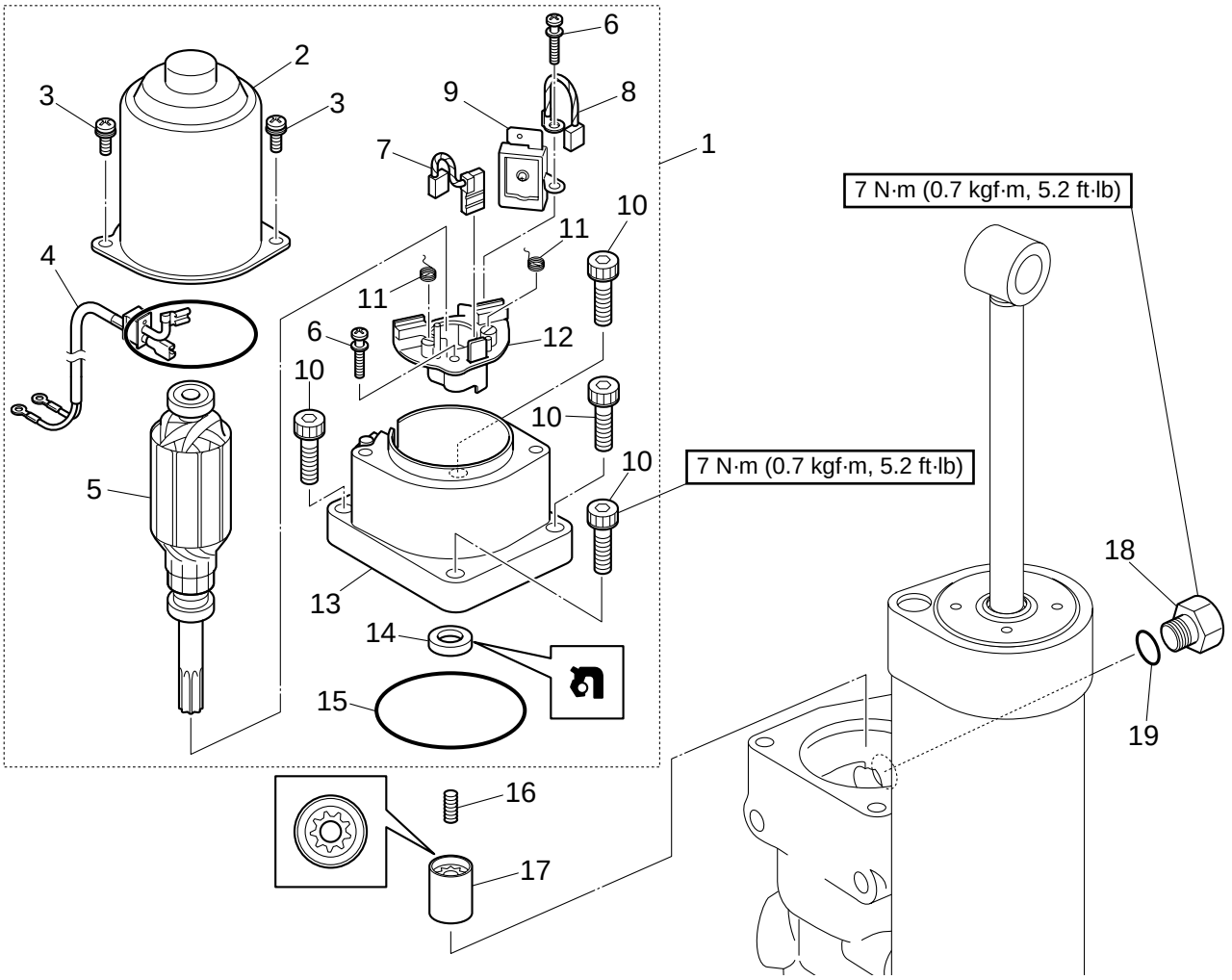
6. Fasten the PTT motor lead ⑩ and the speedometer hose ⑬ with a plastic tie ⑭.



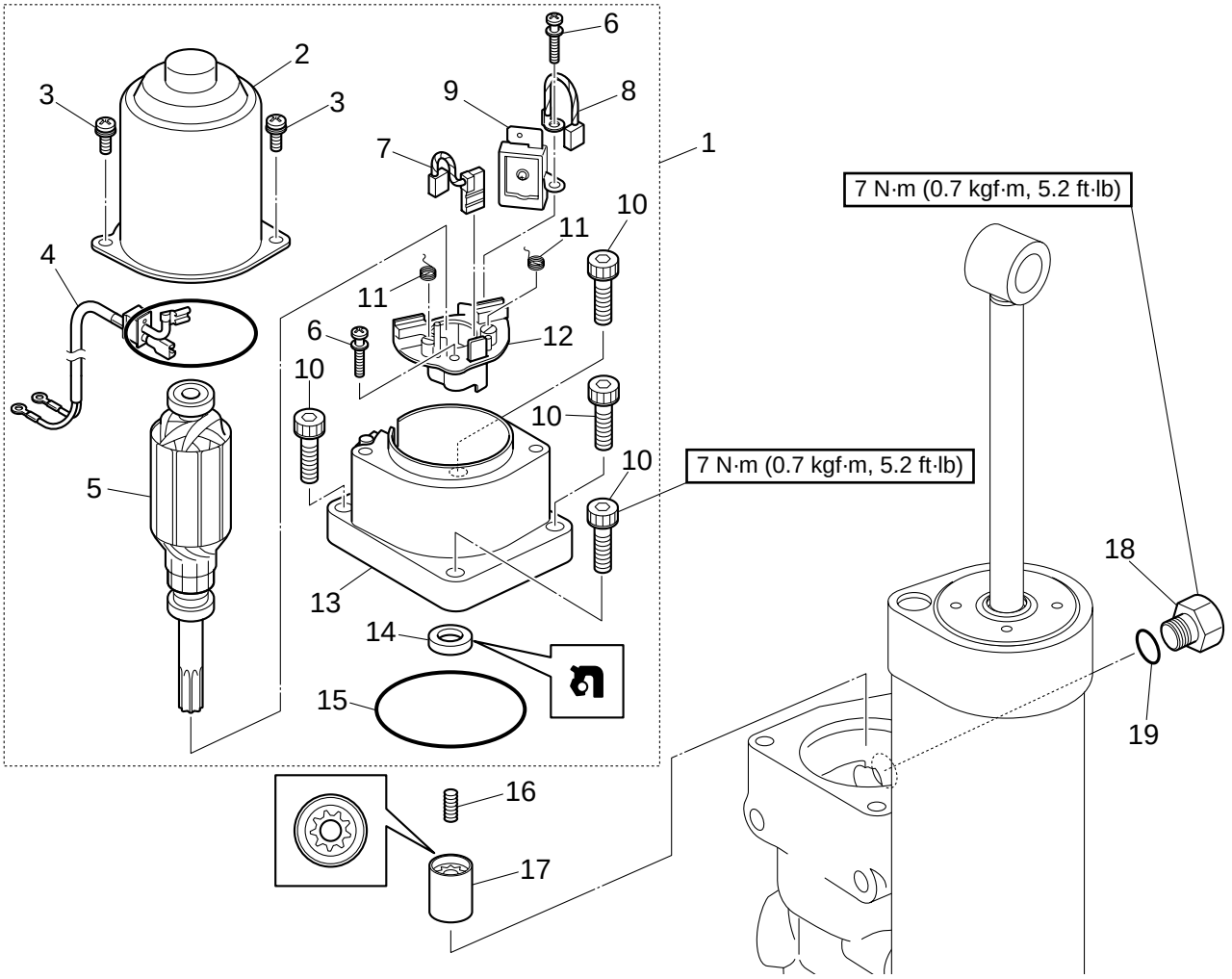
7. Install the corrugated tube ⑮, and then fasten it with the plastic ties ⑯.



PTT motor



No.	Part name	Q'ty	Remarks
1	PTT motor assembly	1	
2	Stator	1	
3	Screw	2	M4 × 14 mm
4	PTT motor lead	1	
5	Armature	1	
6	Screw	2	M3 × 20 mm
7	Brush	1	
8	Brush	1	
9	Circuit breaker	1	
10	Bolt	4	M6 × 20 mm
11	Spring	2	
12	Brush holder	1	
13	PTT motor base	1	
14	Oil seal	1	**Not reusable**
15	O-ring	1	**Not reusable**
16	Spring	1	
17	Shaft connector	1	



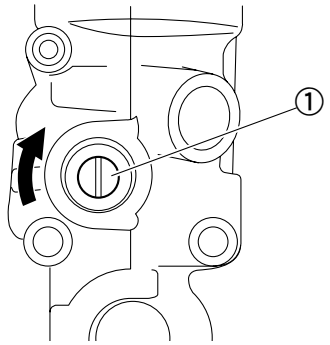
No.	Part name	Q'ty	Remarks
18	Reservoir cap	1	
19	O-ring	1	**Not reusable**

Removing the PTT motor

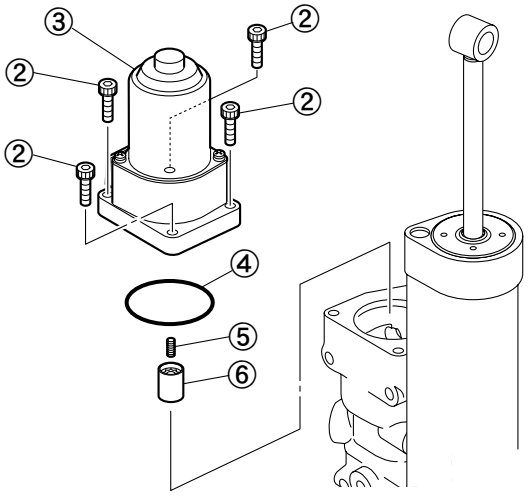
⚠ WARNING

Make sure that the tilt ram is fully extended before removing the PTT motor. Otherwise, fluid can spurt out from the unit due to internal pressure.

1. Fully extend the tilt ram, and then open the manual valve ① by turning it clockwise.

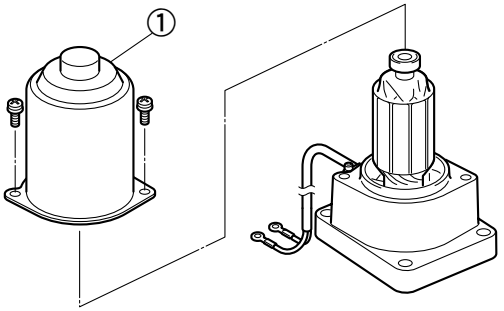


2. Remove the PTT motor base bolts ②, and then remove the PTT motor assembly ③, the O-ring ④, the spring ⑤, and the shaft connector ⑥.

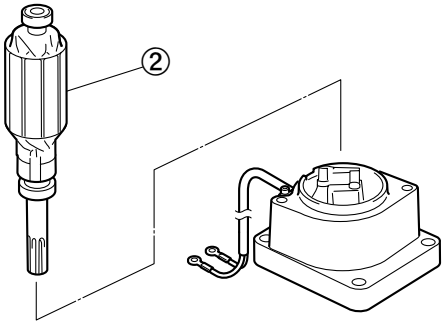


Disassembling the PTT motor

1. Remove the stator ①.

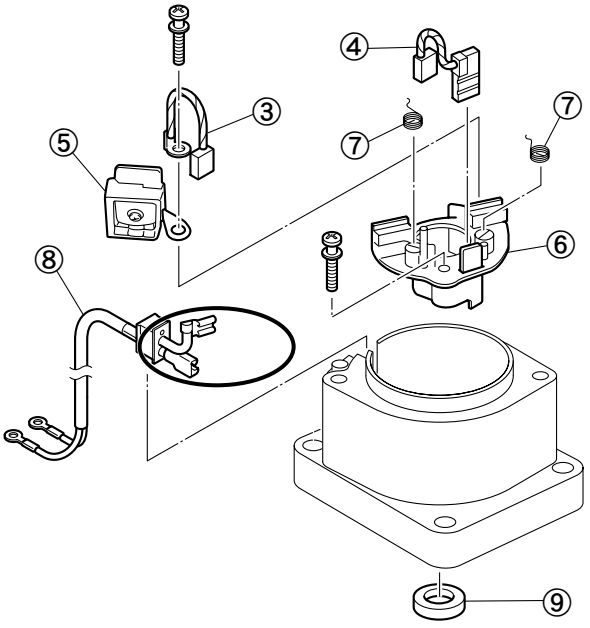


2. Remove the armature assembly ②.



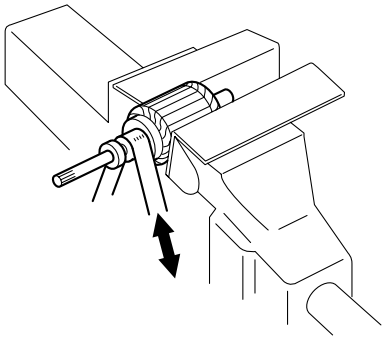
3. Remove the brushes ③, ④, the circuit breaker ⑤, the brush holder ⑥, the springs ⑦, and the PTT motor lead ⑧.

4. Remove the oil seal ⑨.

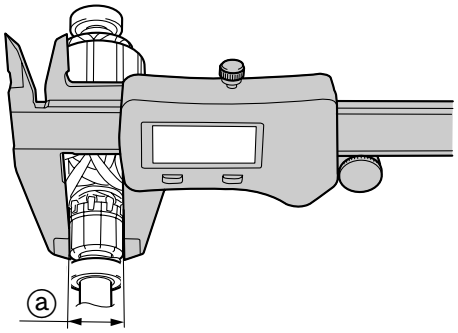


Checking the PTT motor

1. Check the commutator. Clean with 600–grit sandpaper and compressed air if dirty.

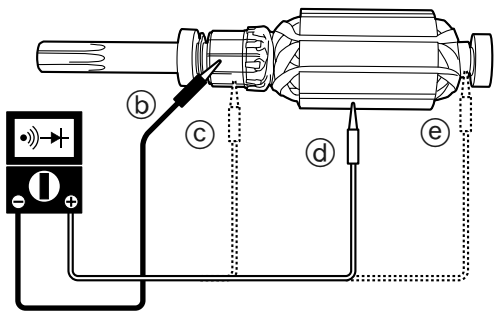


2. Measure the commutator diameter ⓐ. Replace the armature assembly if below specification.



Motor commutator standard diameter ⓐ:
16.3 mm (0.64 in)
Wear limit: 14.9 mm (0.59 in)

3. Check the armature continuity. Replace the armature assembly if out of specification.



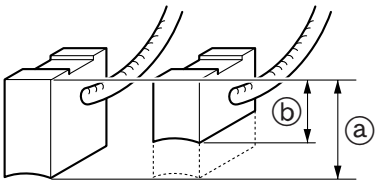
Armature continuity:			
ⓑ	ⓒ	ⓓ	ⓔ
○	○		

Digital circuit tester: 90890-03174

4. Check the bearing. Replace the armature assembly if damaged.

Checking the brush

1. Measure the length of each brush. Replace if below specification.



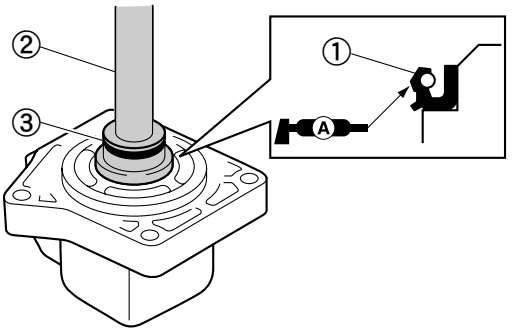
Brush standard length ⓐ:
7.5 mm (0.30 in)
Wear limit ⓑ: 5.1 mm (0.20 in)

Assembling the PTT motor

NOTICE

- **Do not reuse the oil seal and O-rings. Always replace them with new ones.**
- **Do not allow grease or oil to contact the armature commutator.**

1. Install a new oil seal ①.



Driver rod L3 ②: 90890-06652
Needle bearing attachment ③:
90890-06617

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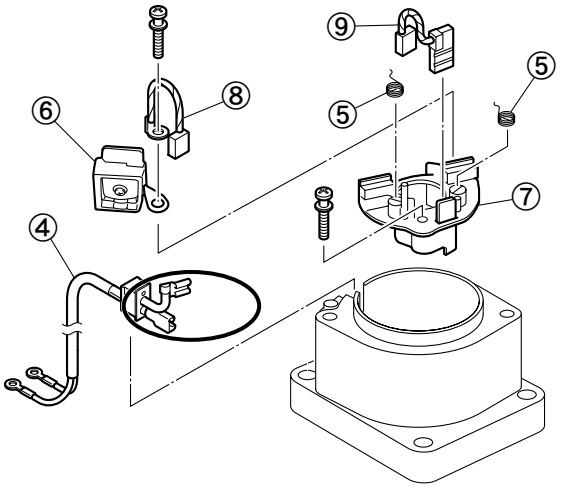
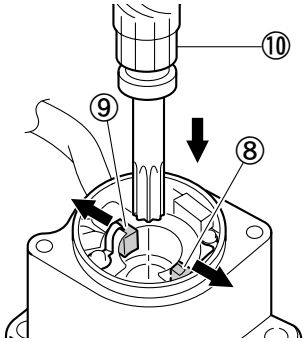
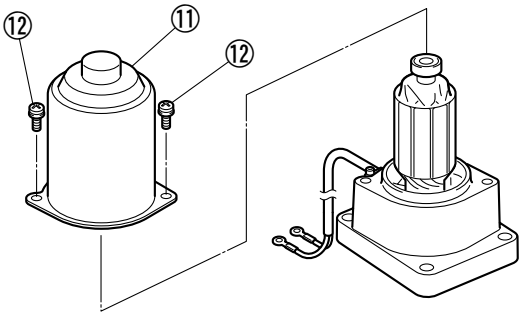
2. Install the PTT motor lead ④, the springs ⑤, the circuit breaker ⑥, the brush holder ⑦, and the brushes ⑧ and ⑨.



3. Push the brushes ⑧ and ⑨ into the brush holder, and then install the armature assembly ⑩.

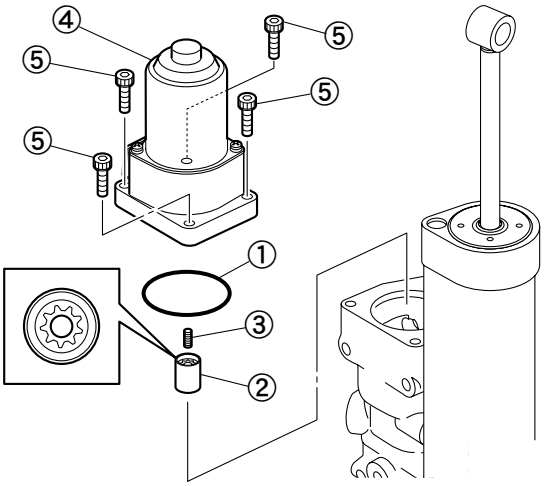


4. Install the stator ⑪, and then tighten the screws ⑫.



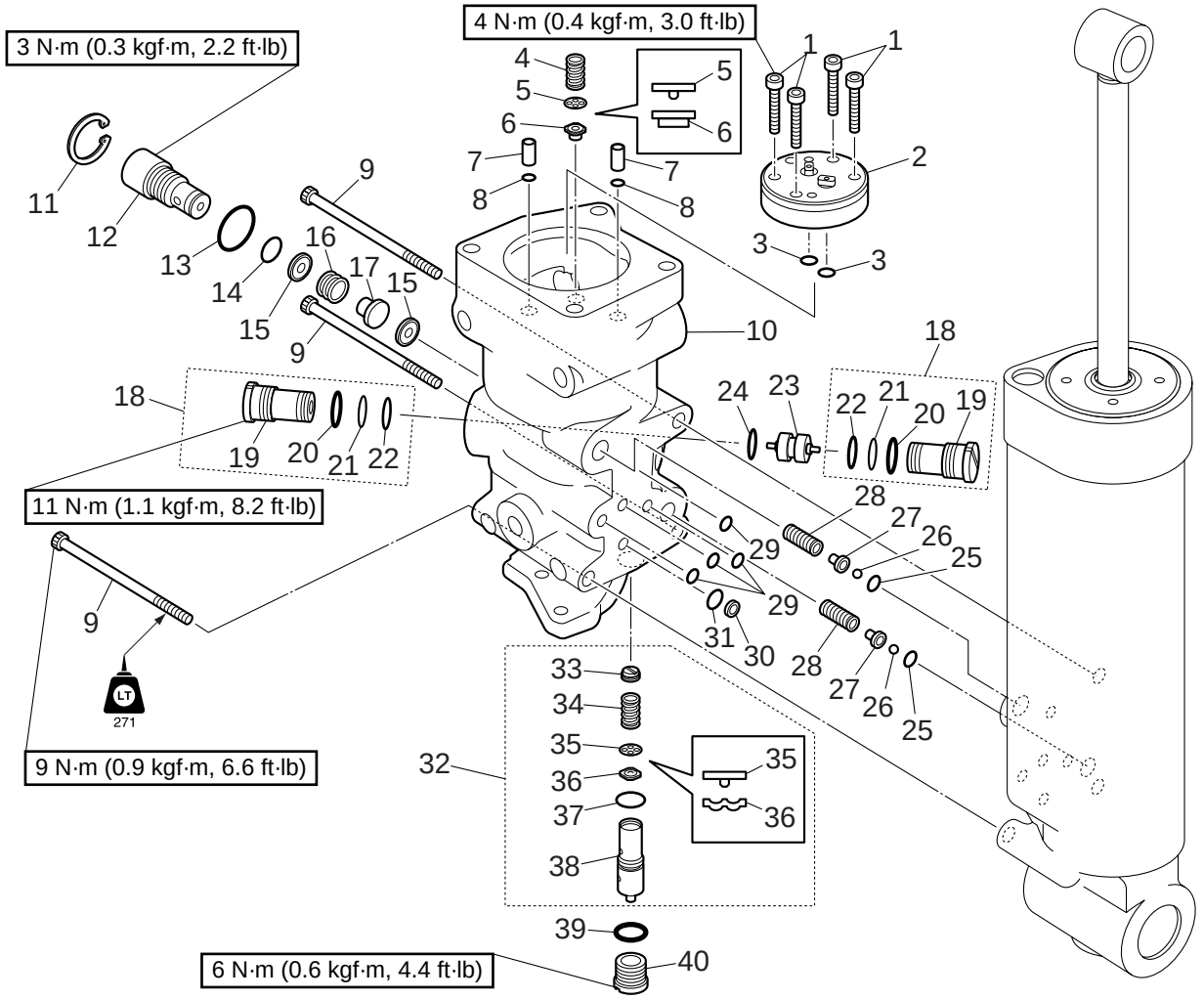
Installing the PTT motor

1. Install a new O-ring ①, the shaft connector ②, the spring ③, and the PTT motor assembly ④ to the gear pump housing, and then tighten the PTT motor assembly bolts ⑤ to the specified torque.

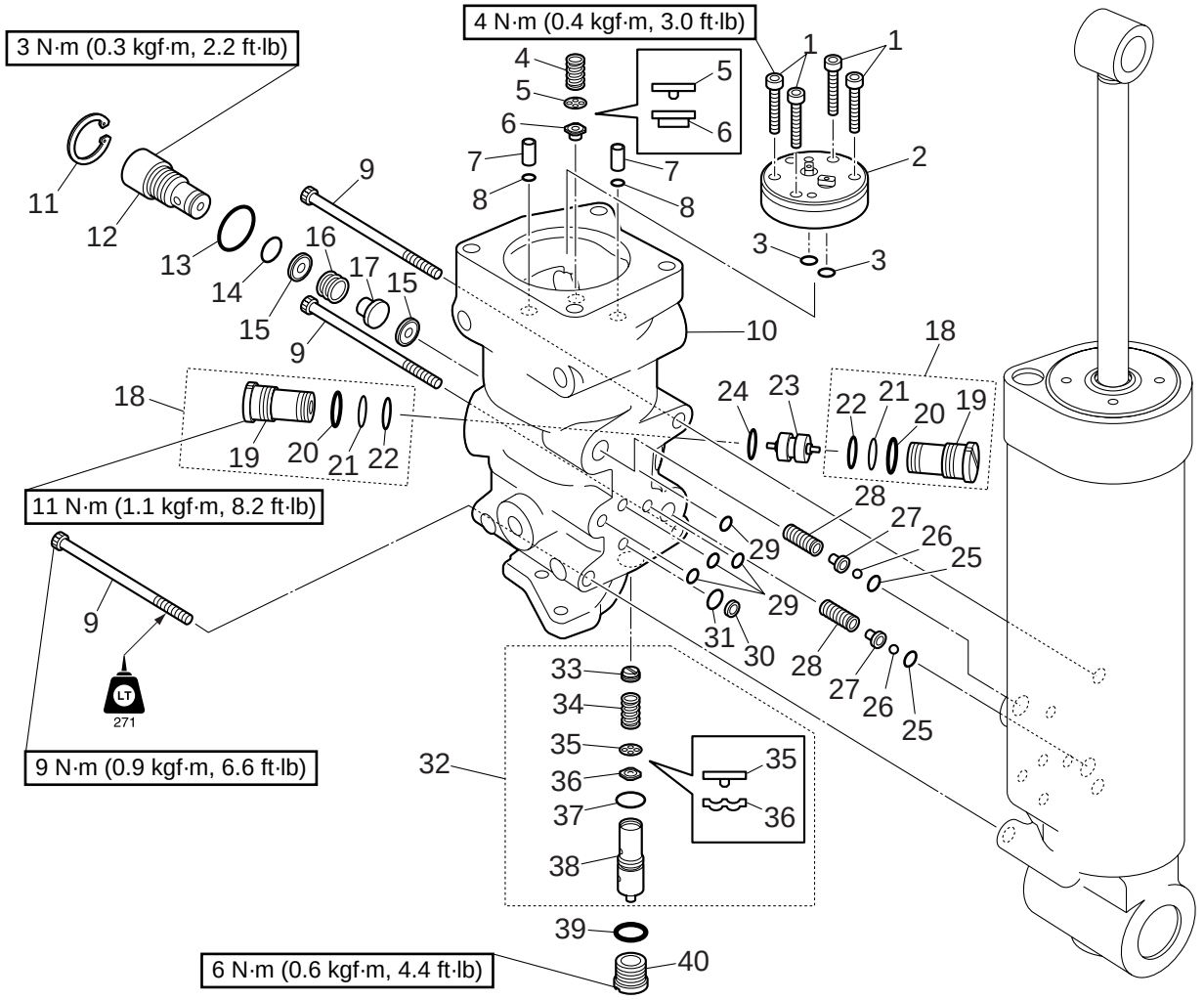


PTT motor assembly bolt ⑤:
7 N·m (0.7 kgf·m, 5.2 ft·lb)

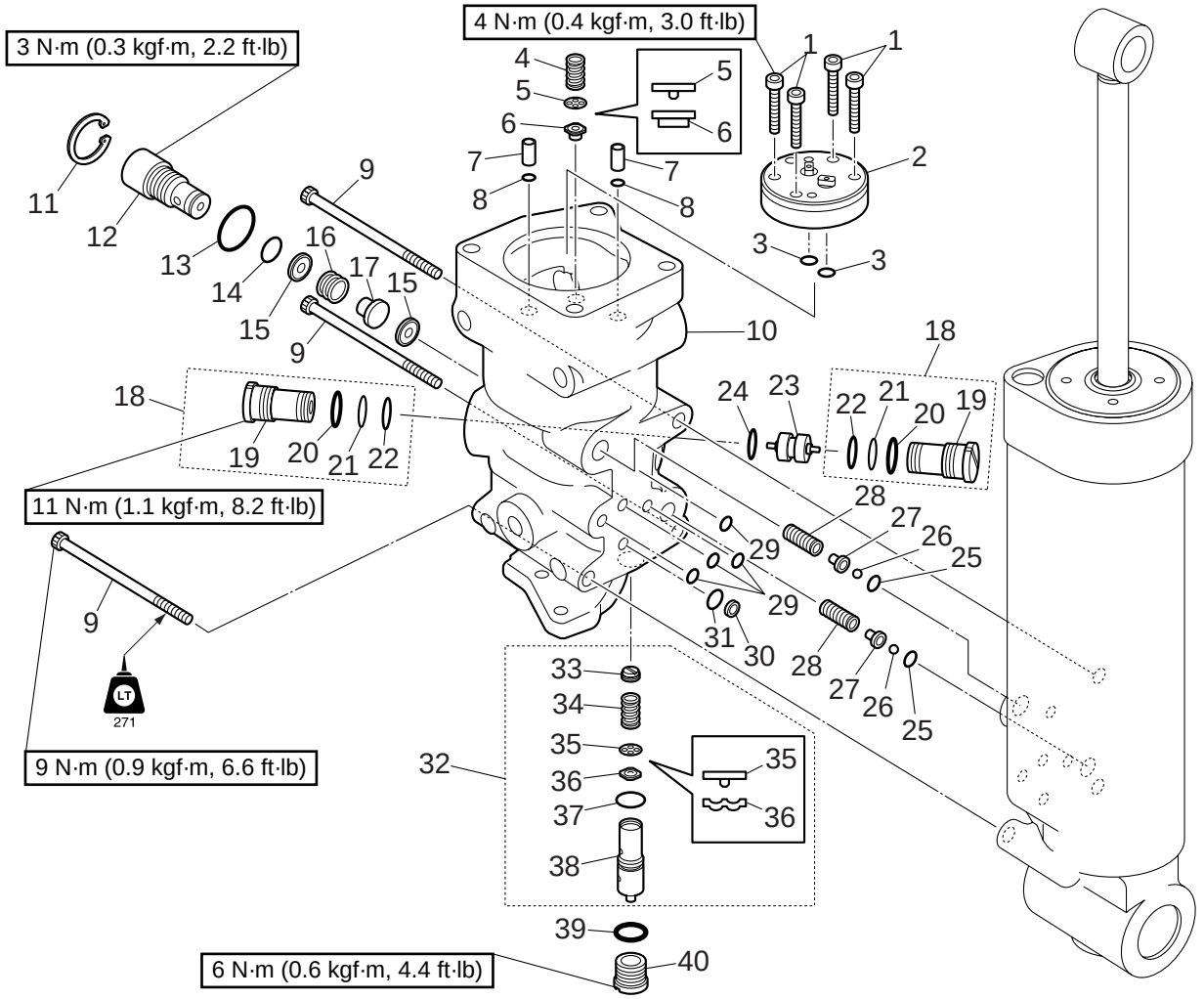
PTT gear pump



No.	Part name	Q'ty	Remarks
1	Bolt	4	M4 × 25 mm
2	Gear pump assembly	1	
3	O-ring	2	**Not reusable**
4	Spring	1	
5	Valve pin	1	
6	Valve seal	1	
7	Filter	2	
8	O-ring	2	**Not reusable**
9	Bolt	3	M6 × 75 mm
10	Gear pump housing	1	
11	Circlip	1	
12	Manual valve	1	
13	O-ring	1	**Not reusable**
14	O-ring	1	**Not reusable**
15	Manual valve seat	2	
16	Spring	1	
17	Adapter	1	



No.	Part name	Q'ty	Remarks
18	Main valve assembly	2	
19	Main valve	2	
20	O-ring	2	**Not reusable**
21	O-ring	2	**Not reusable**
22	O-ring	2	**Not reusable**
23	Shuttle piston	1	
24	O-ring	1	**Not reusable**
25	O-ring	2	**Not reusable**
26	Ball	2	
27	Absorber valve pin	2	
28	Spring	2	
29	O-ring	4	**Not reusable**
30	Filter	1	
31	O-ring	1	**Not reusable**
32	Relief valve assembly	1	
33	Lock screw	1	
34	Spring	1	

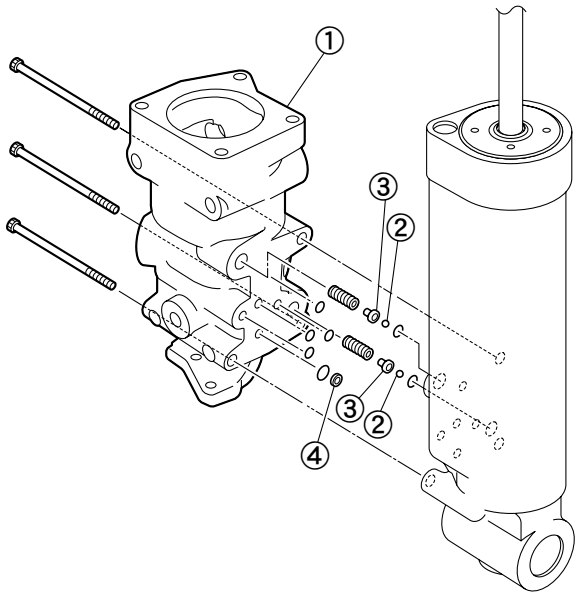


No.	Part name	Q'ty	Remarks
35	Valve pin	1	
36	Valve seal	1	
37	O-ring	1	**Not reusable**
38	Relief valve	1	
39	O-ring	1	**Not reusable**
40	Valve lock screw	1	

Disassembling the gear pump housing

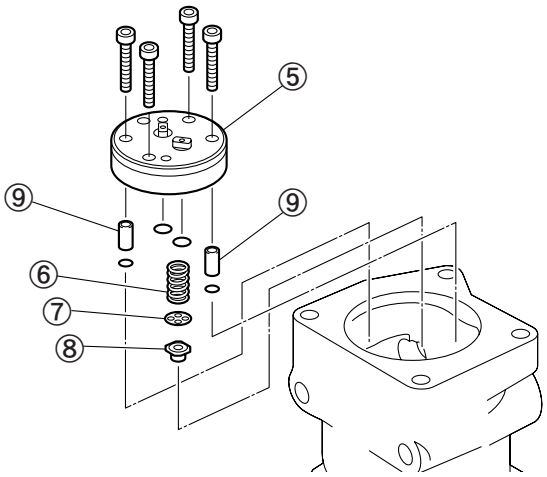
1. Remove the gear pump housing ①.

2. Remove the balls ②, the absorber valve pins ③, and the filter ④.

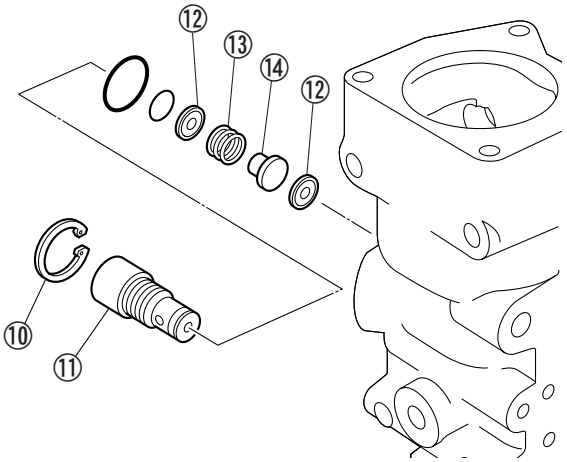


3. Remove the gear pump assembly ⑤.

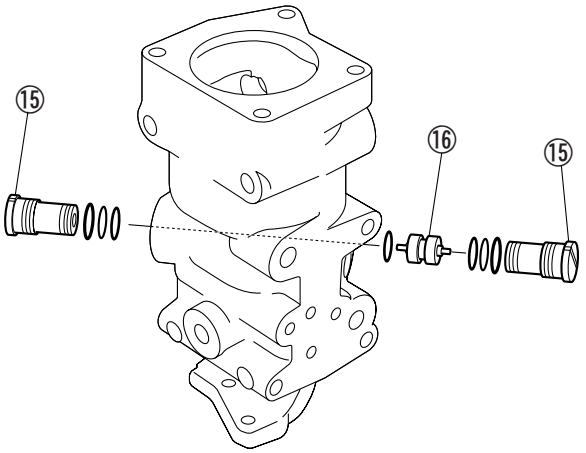
4. Remove the spring ⑥, the valve pin ⑦, the valve seal ⑧, and the filters ⑨.



5. Remove the circlip ⑩, and then remove the manual valve ⑪, the manual valve seats ⑫, the spring ⑬, and the adapter ⑭.

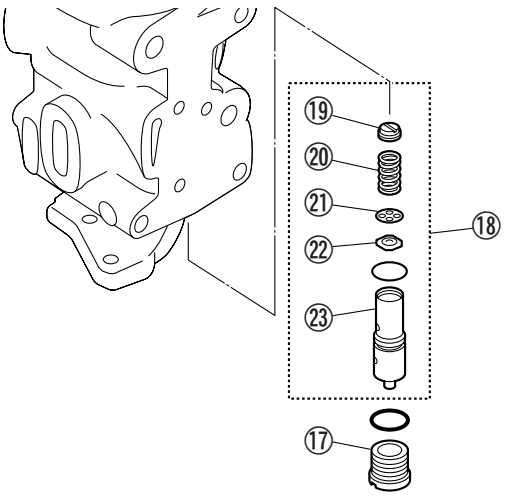


6. Remove the main valves ⑮ and the shuttle piston ⑯.



7. Remove the valve lock screw ⑰ and the relief valve assembly ⑱.

8. Remove the lock screw ⑲, the spring ⑳, the valve pin ㉑, and the valve pin seal ㉒ from the relief valve ㉓.



TIP:
When disassembling the relief valve assembly ⑱, make sure to note down the number of turns the lock screw ⑲ is turned out from its original position.

Checking the gear pump
1. Check the operation of the gear pump shafts. Replace the gear pump assembly if the shafts do not rotate smoothly.

Checking the gear pump housing
1. Check the gear pump housing. Replace if corroded or cracked.

Checking the valve seal
1. Check the main valve seal assembly and the absorber valve pin assemblies. Replace if damaged.
2. Check the main valves and the shuttle piston. Replace if damaged.
3. Check the relief valve assembly. Replace if damaged.
4. Check the manual valve and the spring. Replace if damaged.

Checking the filter
1. Check the filters. Clean if there is dirt or residues.

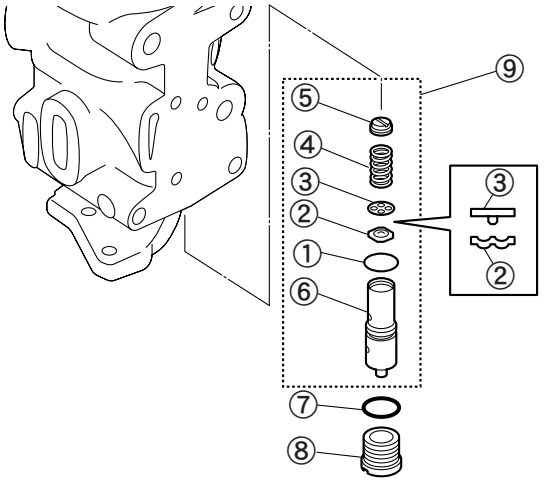
Assembling the gear pump housing
Lubricate the parts with ATF Dexron II during assembly.

NOTICE
- **Do not use a rag when assembling the PTT unit because dust and particles on the PTT unit can lead to poor performance.**
- **Do not reuse the O-rings. Always replace them with new ones.**

1. Install a new O-ring ①, the valve seal ②, the valve pin ③, the spring ④, and the lock screw ⑤ to the relief valve ⑥.

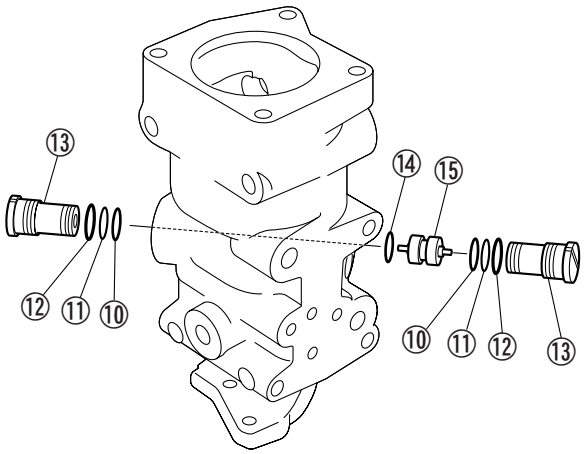
TIP:
Turn in the lock screw ⑤ the same number of turns as it was turned out when removed.

2. Install a new O-ring ⑦, to the valve lock screw ⑧.
3. Install the relief valve assembly ⑨, and then tighten the valve lock screw ⑧ to the specified torque.



Valve lock screw ⑧:
6 N·m (0.6 kgf·m, 4.4 ft·lb)

4. Install new O-rings ⑩, ⑪, and ⑫ to the main valves ⑬.
5. Install a new O-ring ⑭ to the shuttle piston ⑮.
6. Install the shuttle piston ⑮, and then tighten the main valves ⑬ to the specified torque.

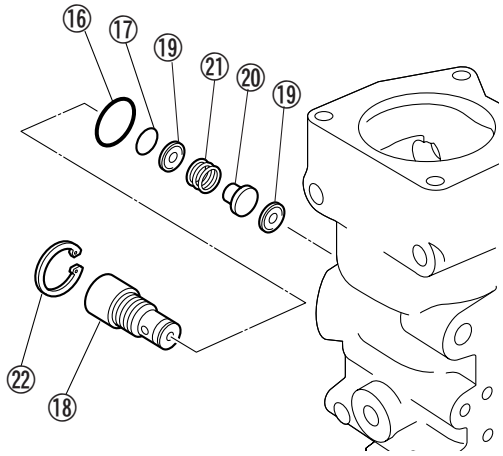


9

Main valve ⑬:
11 N·m (1.1 kgf·m, 8.2 ft·lb)

7. Install new O-rings ⑯ and ⑰ to the manual valve ⑱.

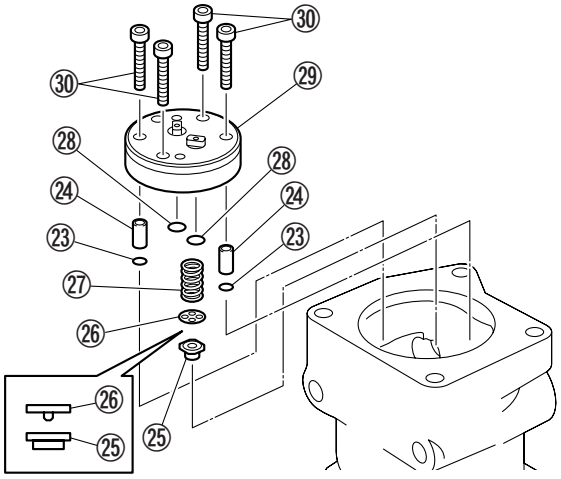
8. Install the manual valve seats ⑲, the adapter ⑳, the spring ㉑, and the manual valve ⑱, and then install the circlip ㉒.



Manual valve ⑱:
3 N·m (0.3 kgf·m, 2.2 ft·lb)

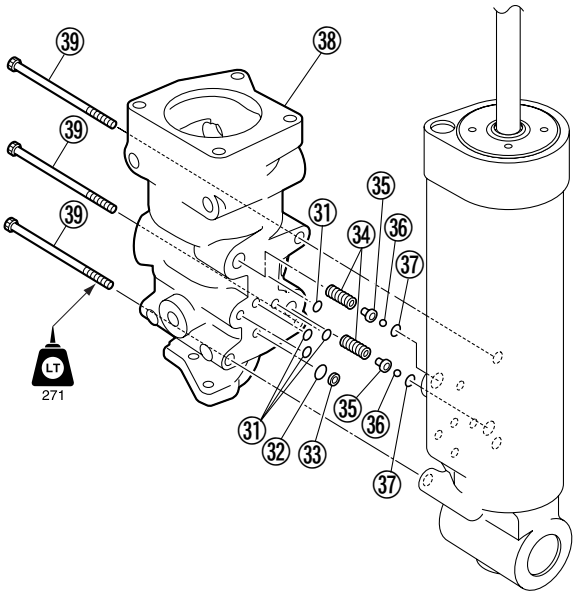
9. Install new O-rings ㉓, the filters ㉔, the valve seal ㉕, the valve pin ㉖, the spring ㉗, and new O-rings ㉘.

10. Install the gear pump assembly ㉙, and then tighten the gear pump bolts ㉚ to the specified torque.



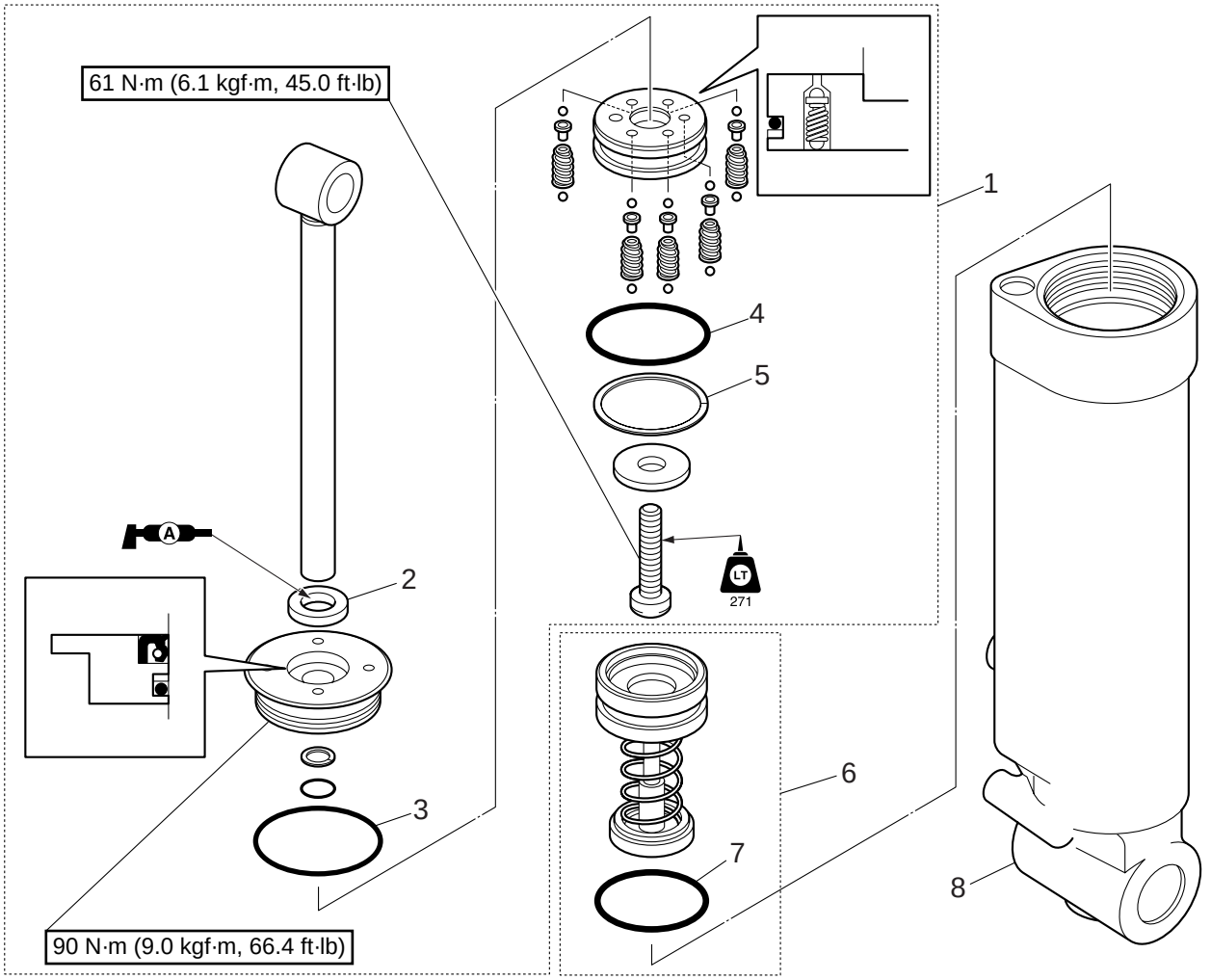
Gear pump bolt ㉚:
4 N·m (0.4 kgf·m, 3.0 ft·lb)

11. Install new O-rings ㉛, ㉜, the filter ㉝, the springs ㉞, the absorber valve pins ㉟, the balls ㊱, new O-rings ㊲, and the gear pump housing ㊳, and then tighten the gear pump housing bolts ㊴ to the specified torque.



Gear pump housing bolt ㊴:
9 N·m (0.9 kgf·m, 6.6 ft·lb)

PTT cylinder

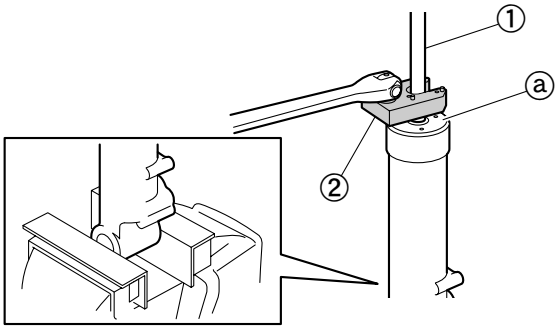


No.	Part name	Q'ty	Remarks
1	Tilt ram assembly	1	
2	Dust seal	1	**Not reusable**
3	O-ring	1	**Not reusable**
4	O-ring	1	**Not reusable**
5	Backup ring	1	
6	Free piston assembly	1	
7	O-ring	1	**Not reusable**
8	Cylinder	1	

9

Disassembling the PTT cylinder

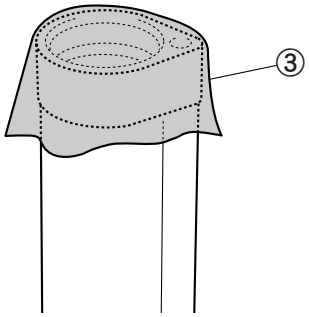
1. Loosen the cylinder end screw ⓐ, and then remove the tilt ram assembly ①.

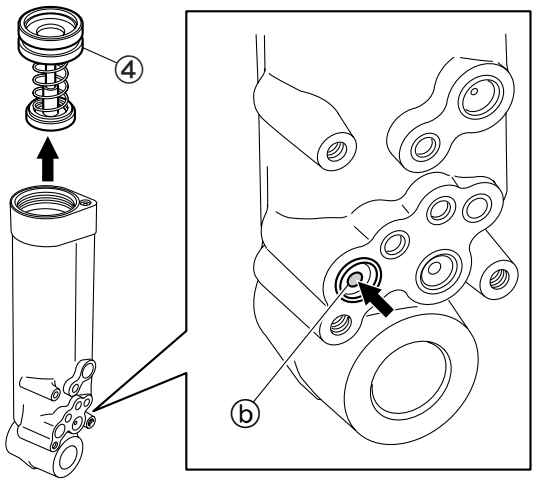


Cylinder-end screw wrench ②:
90890-06568

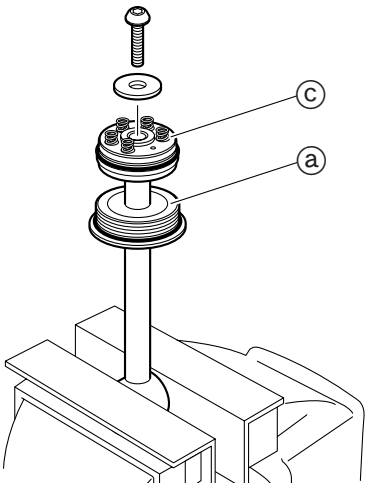
2. Drain the PTT fluid.

3. Cover the PTT cylinder opening with a rag ③, and then blow compressed air through the hole ⓑ to remove the free piston ④. **WARNING! Never look into the PTT cylinder opening while removing the free piston because the free piston and PTT fluid could be forcefully expelled out.**

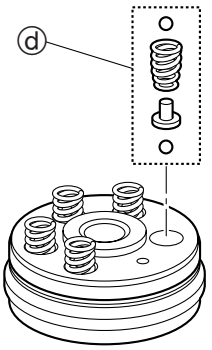




4. Remove the tilt piston ⓒ and the cylinder end screw ⓐ.



5. Remove the absorber valves ⓓ.



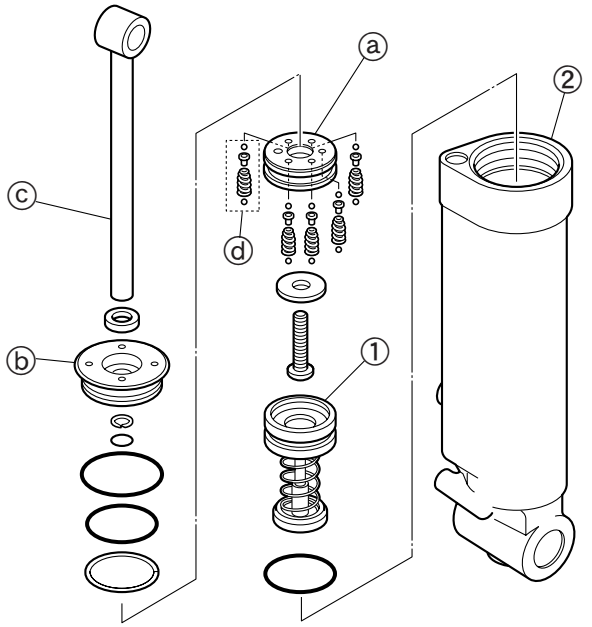
Checking the PTT cylinder and piston

1. Check the tilt piston ⓐ and the free piston ①. Replace if cracked or scratched.

2. Check the cylinder end screw ⓑ and the cylinder ②. Replace if cracked or scratched.

3. Check the tilt ram ⓒ. Polish with 400–600 grit sandpaper if there is light rust, or replace if bent or excessively corroded.

4. Check the absorber valves ⓓ. Clean if there is dirt or residues.



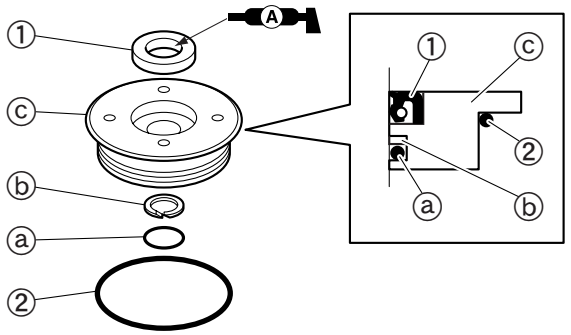
Assembling the PTT cylinder

Lubricate the parts with ATF Dexron II during assembly.

NOTICE

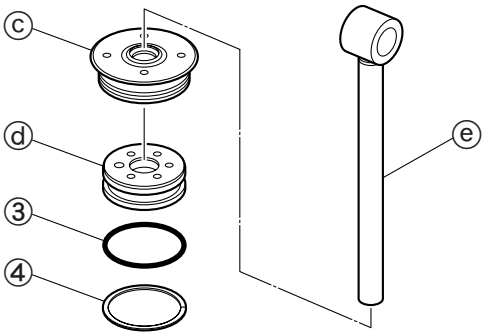
- **Do not use a rag when assembling the PTT unit because dust and particles on the PTT unit can lead to poor performance.**
- **Do not reuse the dust seal and O-rings. Always replace them with new ones.**

1. Install a new dust seal ①, new O-rings ② and ⓐ, and the backup ring ⓑ to the cylinder end screw ⓒ.



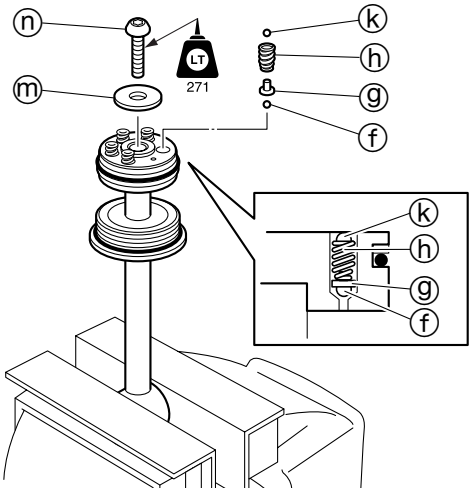
2. Install a new O-ring ③ and the backup ring ④ to the tilt piston ⓓ.

3. Install the cylinder end screw ⓒ and the tilt piston ⓓ to the tilt ram ⓔ.



4. Install the balls ⓕ, the absorber valve pins ⓖ, the springs ⓗ, and the balls ⓚ.

5. Install the washer ⓜ and the tilt piston bolt ⓝ, and then tighten the tilt piston bolt ⓝ to the specified torque.

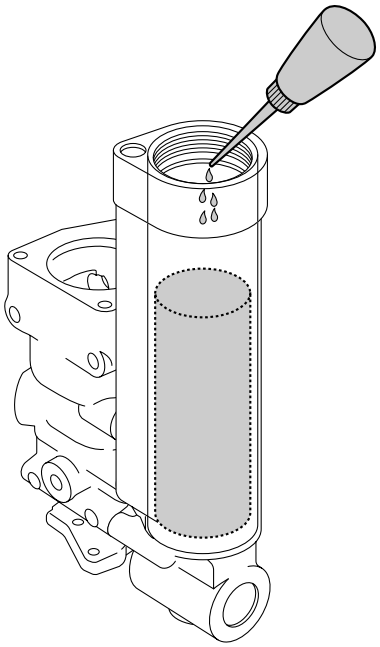


Tilt piston bolt ⓝ:
61 N·m (6.1 kgf·m, 45.0 ft·lb)

6. Install the gear pump housing. See “Assembling the gear pump housing” (9-56).

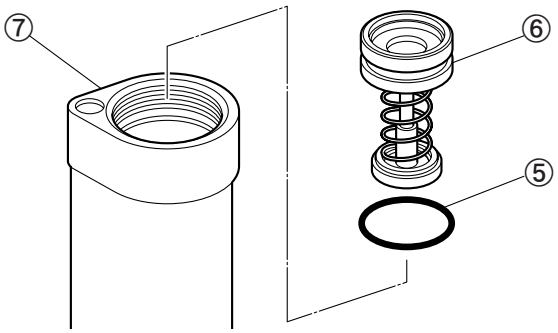
7. Fill the cylinder with the recommended PTT fluid to about 60 % of the cylinder capacity.

9



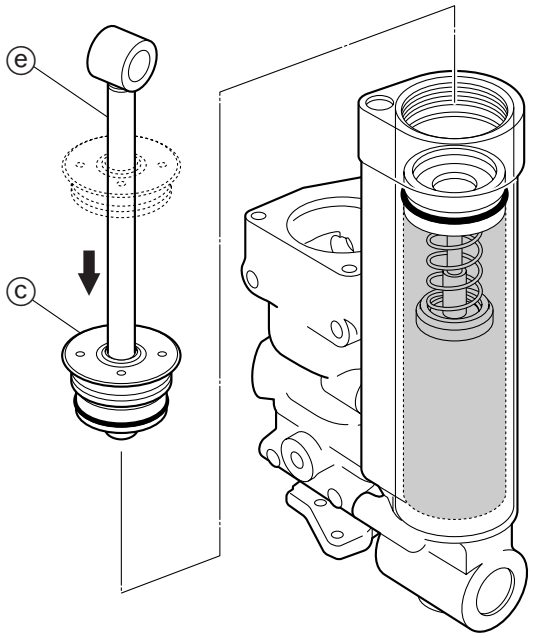
Recommended PTT fluid: ATF Dexron II

8. Install a new O-ring ⑤ to the free piston ⑥, and then install the free piston ⑥ into the cylinder ⑦.

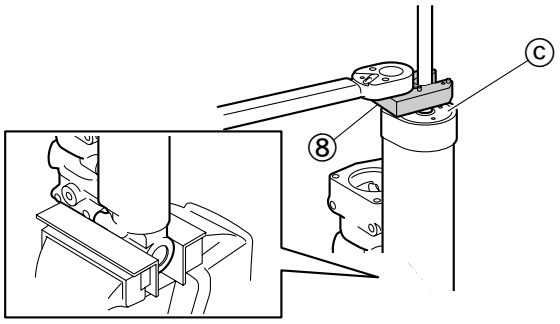


9. Place the cylinder end screw ⓒ at the bottom of the tilt ram ⓔ.

10. Install the tilt ram assembly into the cylinder.



11. Tighten the cylinder end screw ⓒ to the specified torque.



Cylinder-end screw wrench ⑧:
90890-06568

Cylinder end screw ⓒ:
90 N·m (9.0 kgf·m, 66.4 ft·lb)

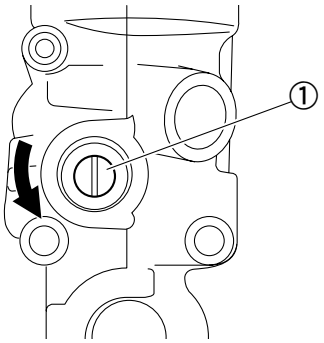
12. Install the PTT motor. See “Installing the PTT motor” (9-51).

Bleeding the PTT unit

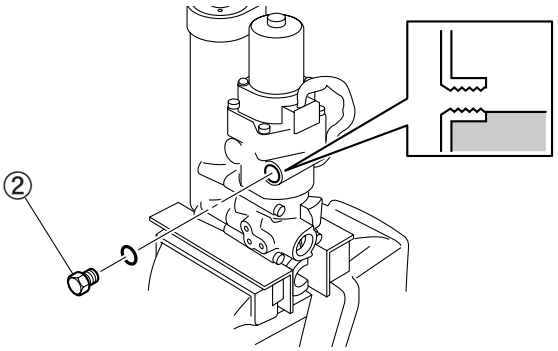
Make sure that the tilt ram is fully extended.

1. Place the PTT unit in an upright position.

2. Turn the manual valve ① counterclockwise to close it.



3. Remove the reservoir cap ②, and then check the fluid level in the reservoir.



Recommended PTT fluid: ATF Dexron II

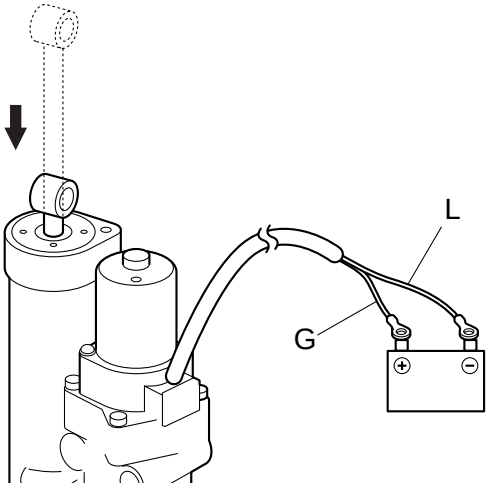
TIP:

- If the fluid is at the correct level, a small amount of fluid should overflow out of the filler hole.
- If fluid is below the correct level, add the recommended PTT fluid.

4. Install the reservoir cap ②, and then tighten it to the specified torque.

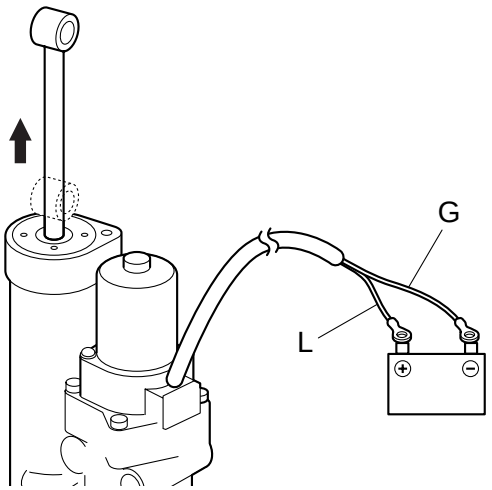
Reservoir cap ②:
7 N·m (0.7 kgf·m, 5.2 ft·lb)

5. Connect the PTT motor leads to the battery terminals to fully retract the tilt ram.



Ram	PTT motor lead	Battery terminal
Down	Green (G)	⊕
	Blue (L)	⊖

6. Reverse the PTT motor lead connections between the battery terminals to fully extend the tilt ram.



Ram	PTT motor lead	Battery terminal
Up	Blue (L)	⊕
	Green (G)	⊖

TIP:

- Repeat the step 5 and step 6 to fully extend and retract the tilt ram 4 or 5 times.
- If the tilt ram does not move up and down easily, push and pull on the ram to assist the operation.

9

7. Fully extend the tilt ram.

8. Remove the reservoir cap, and then check the fluid level in the reservoir. **WARNING! Make sure that the tilt ram is fully extended when removing the reservoir cap. Otherwise, fluid can spurt out from the unit due to internal pressure**.

TIP:

If the fluid is below the correct level, add fluid to the correct level, and then repeat the step 4–step 8 until the fluid remains at the correct level.

9. Install the reservoir cap, and then tighten the reservoir cap to the specified torque.

Reservoir cap: 7 N·m (0.7 kgf·m, 5.2 ft·lb)

Maintenance

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Maintenance interval chart 10-1

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Checking the cooling water pilot hole 10-3
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Checking the engine start switch and engine shut-off switch .. 10-4
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Checking the gear oil level 10-5
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Checking the top cowling 10-14
Checking the valve clearance 10-14
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Outline

- To ensure long product life, Selva strongly recommends the specified periodic check and maintenance to be performed according to the maintenance interval chart.
- If replacement parts are necessary, use only genuine Selva parts of equivalent design and quality. Any parts of inferior quality may cause malfunction, and the resulting loss of control could endanger the operator and passengers. Selva genuine parts and accessories are available from Selva dealers.
- The service intervals provided in the Maintenance Chart are based upon “typical” operating conditions that include speed variations, sufficient time for engine warm up and cool-down, medium to light load, and an average cruising speed in 3000 to 4000 r/min range. If your normal operating conditions are more intensive, more frequent servicing will be required, especially the engine oil and gear oil changes. Examples of the intensive operation will be; wide-open-throttle, trolling or idling operations for extended period of time, carrying heavy loads, or frequent starting and stopping or shifting. In most cases, the frequent maintenance pays off in increased engine life and greater owner satisfaction. Consult Selva dealer for additional recommendations.
- The maintenance cycle on these charts assume usage of 100 hours per year and regular flushing of the cooling water passages. Maintenance frequency should be adjusted when operating the engine under adverse conditions such as extended trolling.
- Disassembly or repairs may be necessary depending on the outcome of maintenance checks.
- Expendable or consumable parts and lubricants will lose their effectiveness over time and through normal usage regardless of the warranty period.
- When operating in salt water, muddy, turbid (cloudy), or acidic water, the engine should be flushed with clean water after each use.

Maintenance interval chart

Item	Actions	Initial	Every			Refer to page
		20 hours (3 months)	100 hours (1 year)	300 hours (3 years)	500 hours (5 years)	
Anode(s) (external)	Check/replace		○			8-3 9-40 9-43
Anode(s) (cylinder head)	Check/replace		○			7-42
Anode(s) (exhaust cover, exhaust guide)	Replace				○	7-49 9-33
Battery (electrolyte level, terminal)	Check/charge/replace	○	○			10-3
Cooling water leakage	Check/replace	○	○			10-8
Cowling clamp	Check		○			10-14
Engine starting condition/ noise	Check	○	○			10-4
Engine idle speed/noise	Check	○	○			10-9
Engine oil	Replace	○	○			10-9
Engine oil filter	Replace		○			10-10
Engine start switch/ engine shut-off switch	Check/replace	○	○			10-4

Item	Actions	Initial	Every			Refer to page
		20 hours (3 months)	100 hours (1 year)	300 hours (3 years)	500 hours (5 years)	
Fuel filter (can be disassembled)	Check/replace	○	○			6-10
Fuel hose (high pressure)	Check/replace	○	○			6-1
Fuel hose (low pressure)	Check/replace	○	○			6-1
Fuel pump	Check/replace			○		6-13
Fuel/oil leakage	Check	○	○			6-1
Gear oil	Replace	○	○			10-11
Greasing points	Lubricate	○	○			10-12
Impeller/ water pump housing	Check/replace		○			8-5
Impeller/ water pump housing	Replace			○		8-5 8-19
Pilot water	Check	○	○			10-3
Propeller/propeller nut/ cotter pin	Check/replace	○	○			8-3
PTT unit	Check/replace	○	○			10-13
Shift link/shift cable	Check/adjust/replace	○	○			3-14 10-5
Spark plug(s)	Check/replace		○			7-42
Throttle link/throttle cable	Check/adjust/replace	○	○			3-14 6-21
Thermostat	Check/replace		○			7-49
Timing belt	Check/replace		○			7-12
Valve clearance	Check/adjust				○	7-2 7-4
Water inlet	Check	○	○			10-8
Wiring harness connections/wiring coupler connections	Check/replace	○	○			—
Selva meter/gauge	Check	○	○			—

— : Not applicable

Item	Actions	Every	Refer to page
		1000 hours	
Exhaust guide/ exhaust manifold	Check/replace	○	9-33
Timing belt	Replace	○	7-12

TIP:

When using lead high-sulfur gasoline, checking the valve clearance may be required more frequently than every 500 hours.

Predelivery check

To make the delivery process smooth and efficient, the predelivery checks should be completed as explained below.

Checking the battery

⚠ WARNING

Battery electrolyte is dangerous; it contains sulfuric acid which is poisonous and highly caustic.

Always follow these preventive measures:

- **Avoid bodily contact with electrolyte as it can cause severe burns or permanent eye injuries.**
- **Wear protective eye gear when handling or working near batteries.**

Antidote (EXTERNAL):

- **SKIN - Wash with water.**
- **EYES - Flush with water for 15 minutes and get immediate medical attention.**

Antidote (INTERNAL):

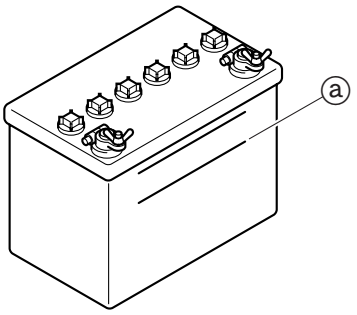
- **Drink large quantities of water or milk followed with milk of magnesia, beaten egg, or vegetable oil. Get immediate medical attention.**

Batteries generate explosive, hydrogen gas. Always follow these preventive measures:

- **Charge batteries in a well-ventilated area.**
- **Keep batteries away from fire, sparks or open flames (example: welding equipment, lighted cigarettes).**
- **DO NOT SMOKE when charging or handling batteries.**

KEEP BATTERIES AND ELECTROLYTE OUT OF THE REACH OF CHILDREN.

1. Check the battery electrolyte level. If the level is at or below the minimum level mark ⓐ, add distilled water until the level is between the maximum and minimum level marks.



2. Check the specific gravity of the electrolyte. Fully charge the battery if below specification.

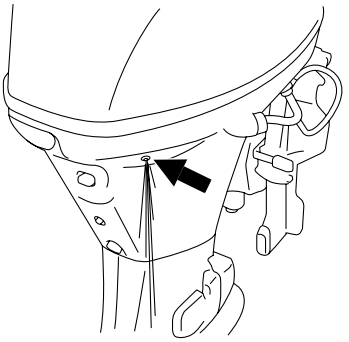
Representative examples:
Recommended battery capacity:
CCA/EN: 430.0 A
20HR/IEC: 70.0 Ah
Electrolyte specific gravity:
1.280 at 20 °C (68 °F)

TIP:

- Batteries vary depending on the manufacturer. The procedures mentioned in this manual may not always apply. Therefore, consult the instruction manual of the battery.
- Disconnect the negative battery cable first, and then the positive battery cable.

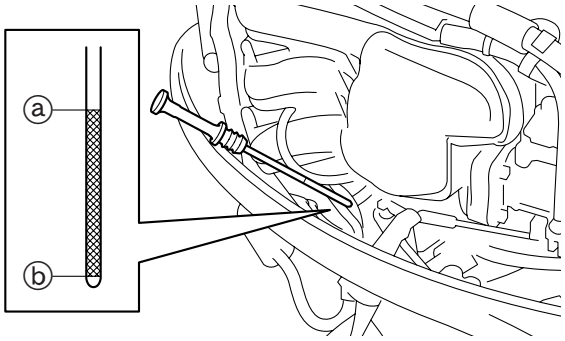
Checking the cooling water pilot hole

1. Start the engine, and then check that cooling water is discharged from the cooling water pilot hole.



Checking the engine oil level

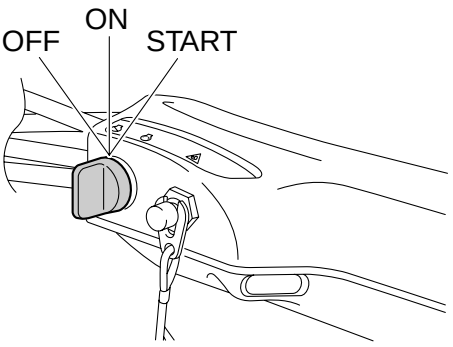
1. Put the outboard motor in an upright position. ***NOTICE:*** **If the motor is not level, the oil level indicated on the dipstick may not be accurate.**
2. Start the engine and warm it up for 5–10 minutes.
3. Stop the engine and leave it at “OFF” for 5–10 minutes.
4. Remove the top cowling.
5. Remove the dipstick and wipe it clean with a rag.
6. Insert the dipstick completely for accurate measurement and remove it again.
7. Check the oil level using the dipstick to make sure the level falls at the center between the upper level ⓐ and the lower level ⓑ. Fill with oil if it is below the lower level ⓑ, or extract to the center level if it is above the upper level ⓐ.



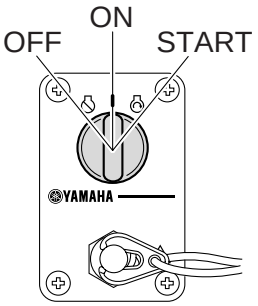
Checking the engine start switch and engine shut-off switch

1. Check that the engine starts when the engine start switch is turned to “START.”
2. Check that the engine turns off when the engine start switch is turned to “OFF.”

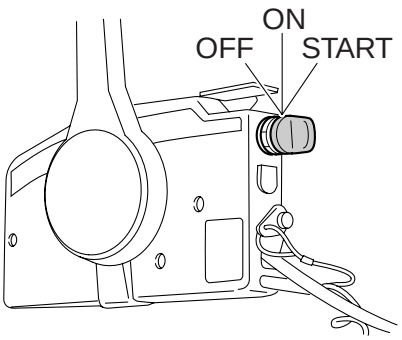
A



B



C

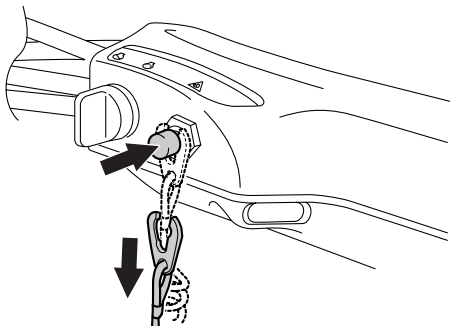


A Tiller handle model
B 704 remote control model
C 703 remote control model

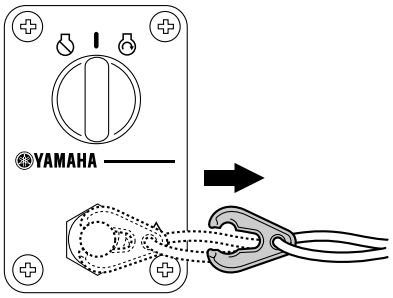
10

3. Check that the engine turns off when the clip is pulled from the engine shut-off switch.
   Check that the engine turns off when the engine shut-off switch is pushed (tiller handle model).

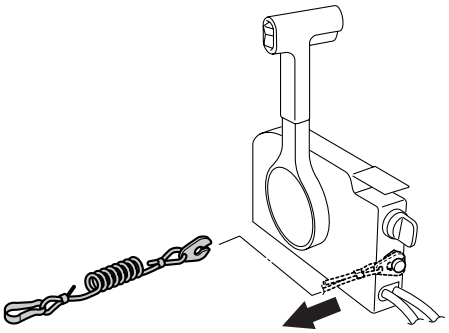
A



B



C



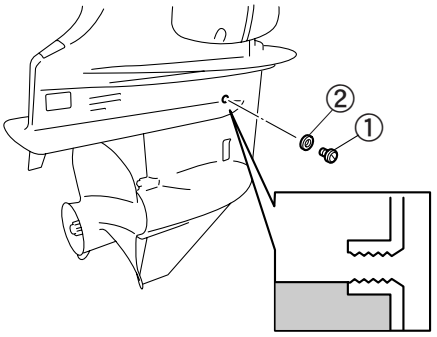
A Tiller handle model
B 704 remote control model
C 703 remote control model

Checking the fuel system

1. Check that the fuel hoses are securely connected. To check the fuel hose connections, see "Fuel hose" (6-1).
   NOTICE: **This is a 4-stroke engine. Never use premixed fuel or 2-stroke outboard motor oil.**

Checking the gear oil level

1. Put the outboard motor in an upright position.
2. Remove the check screw ①, and then check the gear oil level in the lower case.



TIP:
If the oil is at the correct level, a small amount of oil should overflow out of the check hole when the gear oil check screw is removed.

3. Install a new gasket ② and the check screw ①, and then tighten the check screw ① to the specified torque.

Check screw ①:
9 N·m (0.9 kgf·m, 6.6 ft·lb)

Checking the gear shift and throttle operation

⚠ WARNING

Do not overtighten the friction adjuster. If there is too much resistance, it could be difficult to move the remote control lever or the throttle grip, which could result in an accident.

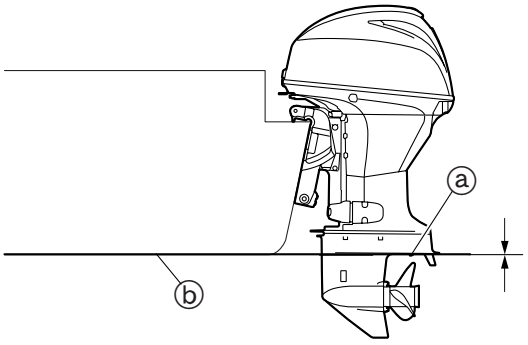
1. Check that the gear shift operates smoothly when the shift lever is shifted from the N to the F or R position (tiller handle model).
   Check that the gear shift operates smoothly when the remote control lever is shifted from the N to the F or R position (remote control model).

TIP:
The shift lever can be operated only when the throttle grip is in the fully closed position (tiller handle model).

2. Check that the throttle operates smoothly when the throttle grip is turned from the fully closed position to the fully open position (tiller handle model).
   Check that the throttle operates smoothly when the remote control lever is shifted from the F or R position to the fully open positions (remote control model).

Checking the outboard motor mounting height

1. Check that the anti-cavitation plate ⓐ is aligned with the bottom of the boat ⓑ. If the mounting height is too high, cavitation will occur and propulsion will be reduced. Besides, the engine speed will increase abnormally and cause the engine to overheat. If the mounting height is too low, water resistance will increase and reduce engine efficiency and performance.



TIP:
The optimum mounting height depends on the combination of the boat and the outboard motor. To determine the optimum mounting height, test run the outboard motor at different heights.

2. Check that the clamp brackets are secured with the clamp bolts.

Checking the PTT system

1. Check that the outboard motor tilts up and down smoothly when operating the PTT unit.

2. Check that there is no abnormal noise produced when the outboard motor is tilted up or down.

3. Check that there is no interference with wires or hoses when steering the tilted-up outboard motor.

4. Check that the trim meter points down when the outboard motor is tilted all the way down (remote control model).

Checking the steering system

1. Check the steering friction for proper adjustment. See “Installing the tiller handle” (3-11) step 16 and step 17.

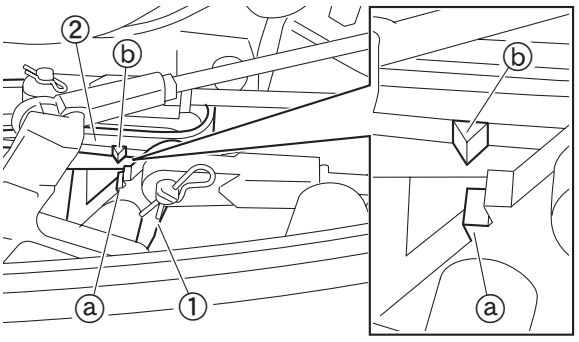
2. Check that the steering operates smoothly.

3. Check that there is no interference with wires or hoses when steering the outboard motor.

Checking the throttle cable and shift cable

1. Set the shift lever to the N position and fully close the throttle grip (tiller handle model).
   Set the remote control lever to the N position and fully close the throttle lever (remote control model).

2. Check that the protrusion ⓐ of the throttle control lever ① is aligned with the protrusion ⓑ on the shift bracket ②.



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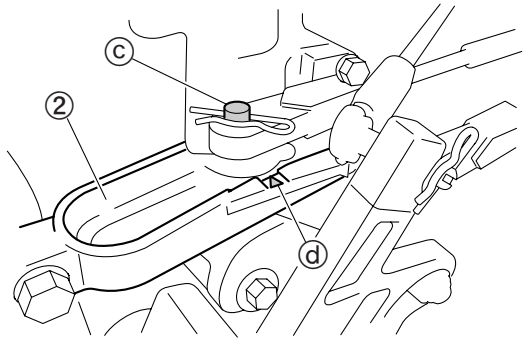
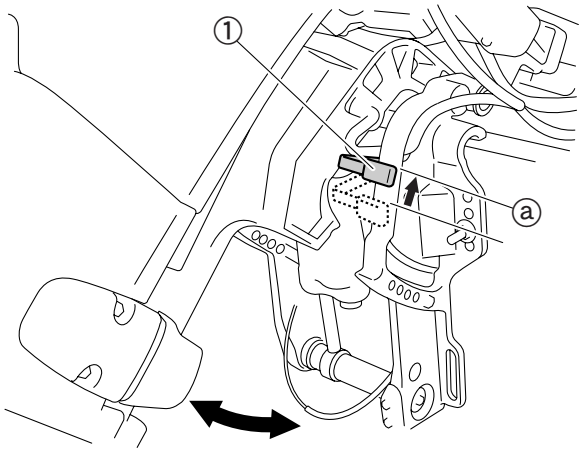
3. Check that the pin ⓒ is aligned with the alignment mark ⓓ on the shift bracket ②.

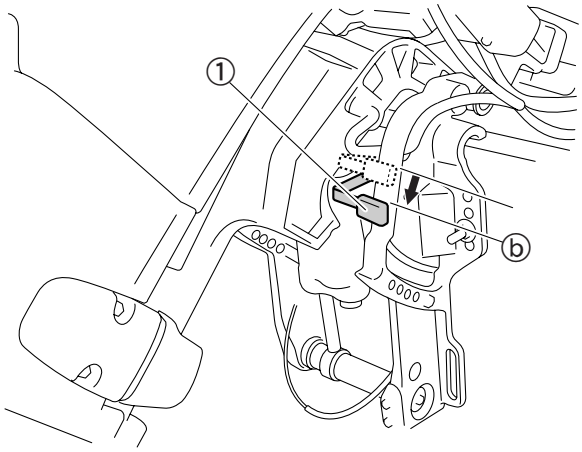


Checking the hydro tilt system

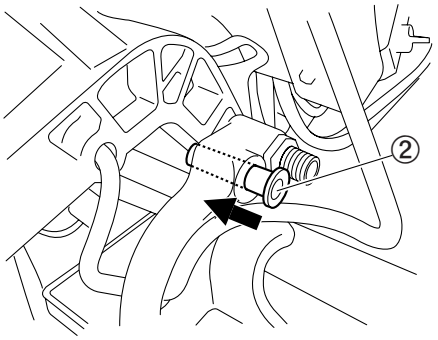
1. Check that the outboard motor tilts up and down smoothly when the tilt lock lever ① is in the release position ⓐ.



2. Check that the outboard motor does not tilt up or down when the tilt lock lever ① is in the lock position ⓑ.



3. Tilt the outboard motor to the fully up position, and then support it with the tilt stop lever ② to check that the lock mechanism of the tilt stop lever works properly.



TIP:

Check that there is no interference with wires or hoses when the outboard motor is tilted up.

Test run

1. Start the engine, and then check that the gear shift operates smoothly.
2. Check the engine idle speed after the engine has been warmed up.
3. Operate at trolling speed.
4. Run the outboard motor according to the break-in procedure.
5. Check that the outboard motor does not tilt up when shifting into reverse and that water does not flow in over the transom.
6. Check that the PTT operates smoothly while the outboard motor is running.

TIP:

The test run is part of the break-in operation.

Break-in

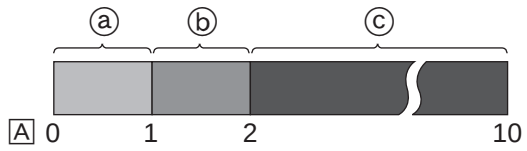
Run the engine under load (in gear with a propeller installed) for 10 hours as follows.

1. For the 1st hour of operation ⓐ:
   Run the engine at varying speeds up to 2000 r/min or approximately half throttle.

2. For the 2nd hour of operation ⓑ:
   Increase engine speed as much as necessary to put the boat on plane (but avoid full-throttle operation), then back off on the throttle while keeping the boat at a planing speed.

3. Remaining 8 hours ⓒ:
   Run the engine at any speed. However, avoid operating at full throttle for more than 5 minutes at a time.

4. After the 1st 10 hours:
   Operate the engine normally.



A Hour

After test run

1. Check for water in the gear oil.

2. Check for fuel leakage in the cowling.

3. Flush the cooling water passage with fresh water. ***NOTICE:*** **Do not perform this procedure on land while the engine is running. Otherwise, the water pump may be damaged and severe engine damage from overheat may take place.**

TIP:
When using the flushing device (flushing hose joint adapter), flush the cooling water passages without starting the engine.

General Periodic Maintenance

Checking the anode

NOTICE

Do not grease, oil, or paint the anodes or the trim tab. Otherwise, they will become ineffective.

1. Check the anodes and trim tab. See "Checking the cylinder head anode" (7-42), "Checking the exhaust cover anode" (7-49), "Checking the exhaust guide anode" (9-33), "Checking the clamp bracket anode" (9-40), "Checking the hydro tilt anode" (9-43), and "Checking the lower unit anode" (8-3).

TIP:
Replace the anodes or trim tab if excessively eroded. In addition, check the ground lead.

Checking the battery

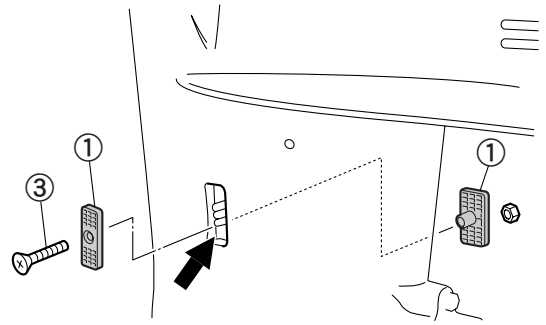
1. Check the battery. See "Checking the battery" (10-3).

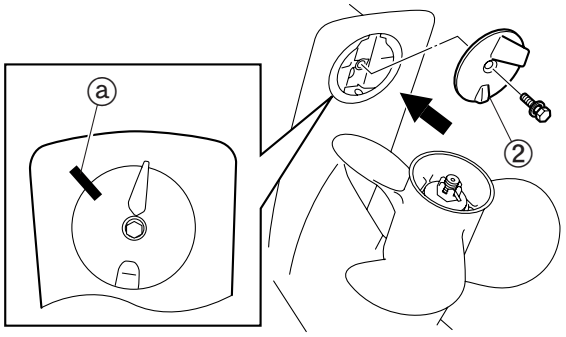
Checking the cooling water passage

1. Remove the water inlet covers ①.

2. Mark an alignment mark ⓐ on the trim tab ② and the lower case, and then remove the trim tab ②.

3. Check the water inlet covers ① and water inlets. Clean if clogged.



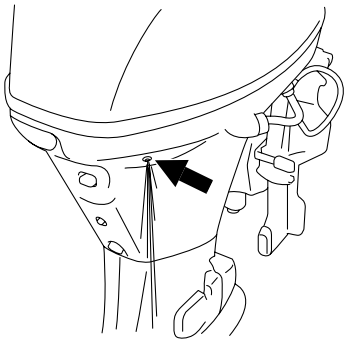


4. Install the water inlet covers ① and the trim tab ②, and then tighten the water inlet cover screw ③ to the specified torque.

Water inlet cover screw ③:
1 N·m (0.1 kgf·m, 0.7 ft·lb)

5. Place the lower unit in water, and then start the engine.

6. Check for water flow at the cooling water pilot hole. If there is no water flow, check the cooling water passage inside the outboard motor.



Checking the engine idle speed

1. Start the engine and warm it up until the idle speed gets stable at 750–850 r/min.

2. Check the engine idle speed using the Selva genuine tachometer (on-board meter) or the YDIS. To connect and operate the YDIS, see the "YDIS (Ver. 1.32 or later) Instruction Manual."

Changing the engine oil

The engine oil should be extracted with an oil changer.

NOTICE

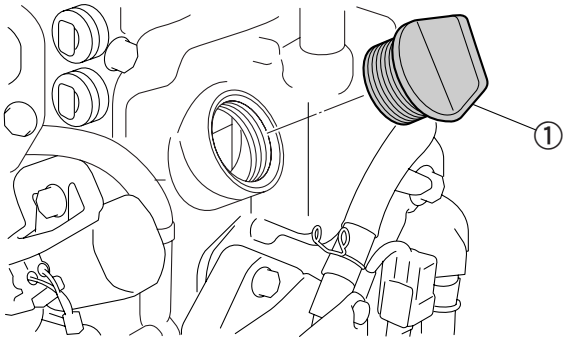
Change the engine oil after the first 20 hours of operation or 3 months, and every 100 hours or at 1-year intervals thereafter.

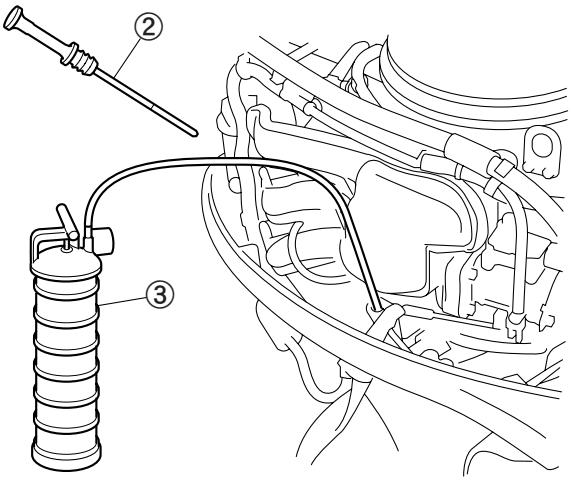
1. Put the outboard motor in an upright position. ***NOTICE:*** **If the outboard motor is not level, the oil level indicated on the dipstick may not be accurate.**

2. Start the engine and warm it up for 5–10 minutes.

3. Stop the engine and leave it "OFF" for 5–10 minutes.

4. Remove the oil filler cap ①. Pull out the dipstick ② and use the oil changer ③ to extract the oil completely.





5. Add the correct amount of oil through the filler hole. Put back the filler cap ① and the dipstick ②. ***NOTICE:*** **Overfilling the oil could cause leakage or damage. If the oil level is above the upper level mark, extract until the level meets the specified capacity.**

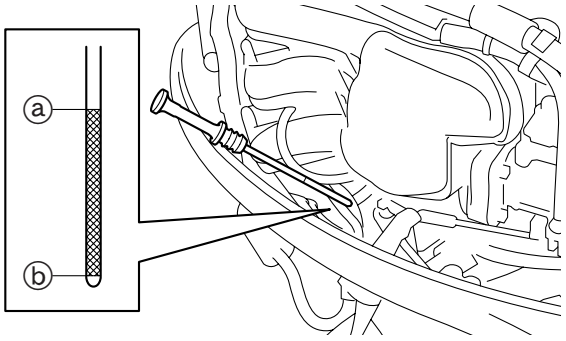
Recommended engine oil:
4-stroke motor oil with combinations of the following SAE and API oil classifications:
API: SE, SF, SG, SH, SJ, or SL
SAE: 5W-30, 10W-30, or 10W-40
Replacement engine oil quantity:
without oil filter replacement:
1.5 L (1.59 US qt, 1.32 lmp qt)

6. Leave the outboard motor "OFF" for 5–10 minutes.

7. Remove the dipstick ② and wipe it clean with a rag.

8. Insert the dipstick ② and remove it again. Make sure to completely insert the dipstick into the dipstick hole. Otherwise, the oil level measurement may be incorrect.

9. Recheck the oil level using the dipstick to make sure that the level falls between the upper level ⓐ and the lower level ⓑ.



10. Start the engine and make sure that the oil pressure alert indicator remains off. Also, make sure that there is no oil leakage. ***NOTICE:*** **If the oil pressure alert indicator comes on or if there is oil leakage, stop the engine and find the cause. Continued operation with a problem could cause severe engine damage.**

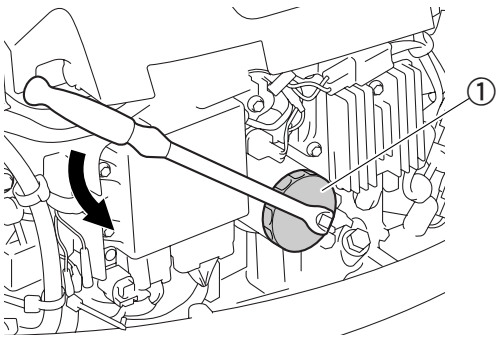
Checking the engine oil level

1. Check the engine oil level. See “Checking the engine oil level” (10-4).

Replacing the oil filter

1. Extract the engine oil with an oil changer. See “Changing the engine oil” (10-9) step 1–step 4.

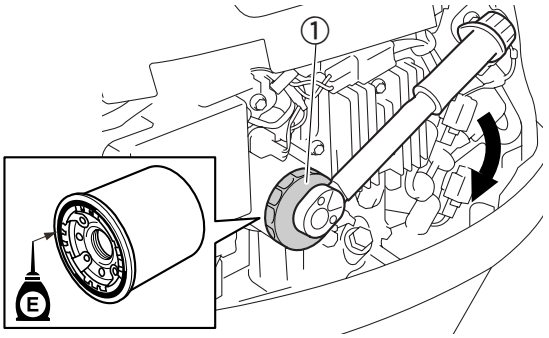
2. Place a rag under the oil filter, and then remove the oil filter.



Oil filter wrench ①: 90890-01426

TIP:
- Wait for more than 5 minutes after turning off the engine to replace the oil filter.
- Make sure to clean up any oil spills.

3. Install the oil filter, and then tighten it to the specified torque.



Oil filter:
18 N·m (1.8 kgf·m, 13.3 ft·lb)

4. Pour the specified amount of the recommended engine oil into the oil filler hole.

Recommended engine oil:
4-stroke motor oil with combinations of the following SAE and API oil classifications:
API: SE, SF, SG, SH, SJ, or SL
SAE: 5W-30, 10W-30, or 10W-40
Replacement engine oil quantity:
with oil filter replacement:
1.7 L (1.80 US qt, 1.50 lmp qt)

5. Install the oil filler cap and dipstick, and then start the engine and warm it up for 5 minutes.

6. Turn off the engine, and then check the oil level. See “Changing the engine oil” (10-9) step 7–step 10.

Checking the engine start switch and engine shut-off switch

1. Check the engine start switch and engine shut-off switch. See “Checking the engine start switch and engine shut-off switch” (10-4).

Checking the fuel filter

1. Check the fuel filter. See “Checking the fuel filter assembly” (6-9).

Checking the fuel joint and fuel hoses (fuel joint-to-fuel injector)

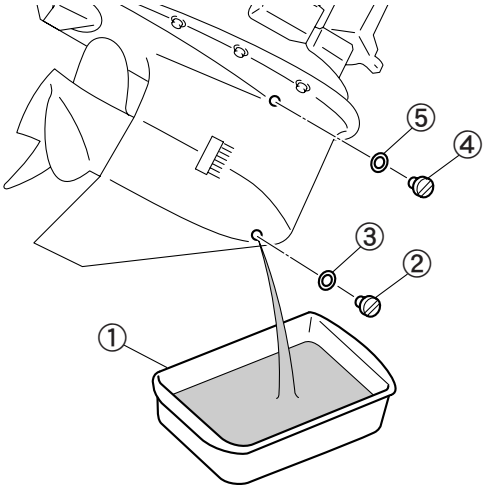
1. Check the fuel joint and fuel hose connections. To check the fuel hose connections, see “Fuel hose” (6-1).

Changing the gear oil

⚠ WARNING

Never get under the lower unit while it is tilted.

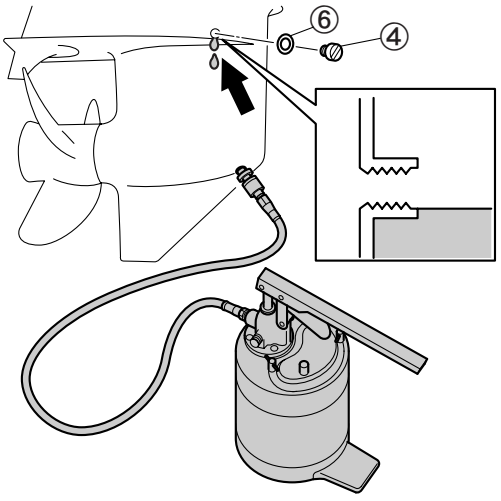
1. Tilt the outboard motor so that the drain screw is at the lowest possible point.
2. Place a drain pan ① under the gear oil drain hole.
3. Remove the drain screw ② and gasket ③. ***NOTICE:*** **If there is an excessive quantity of metal particles on the magnetic gear oil drain screw ②, this can indicate lower unit problem.**
4. Remove the check screw ④ and the gasket ⑤ to allow the oil to drain completely. ***NOTICE:*** **Check the used oil after it has been drained. If the oil is milky, water is getting into the lower case, and this may cause gear damage.**



TIP:

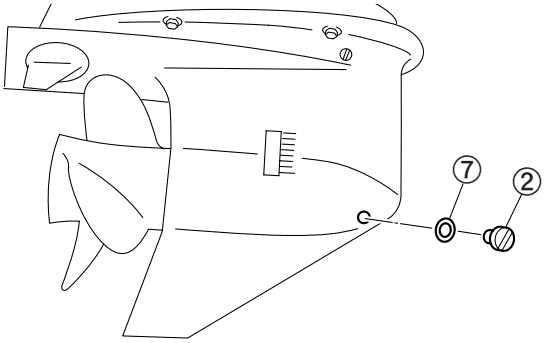
Remove all metal particles before installing the magnetic drain screw.

5. Put the outboard motor in an upright position.
6. Install the gear oil pump into the drain hole and slowly fill with gear oil until oil flows out of the check hole and no air bubbles are visible.
7. Install a new gasket ⑥ and the check screw ④.



Recommended gear oil:
Hypoid gear oil
API: GL-4
SAE: 90
Oil quantity:
0.430 L (0.455 US qt, 0.378 Imp qt)

8. Remove the gear oil pump, and then install a new gasket ⑦ and the drain screw ②.



9. Tighten the check screw ④ and the drain screw ② to the specified torque.

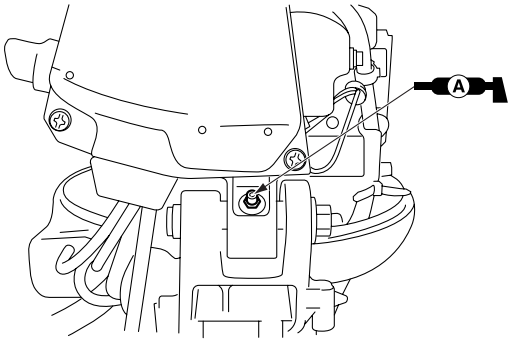
Check screw ④: 9 N·m (0.9 kgf·m, 6.6 ft·lb) Drain screw ②: 9 N·m (0.9 kgf·m, 6.6 ft·lb)

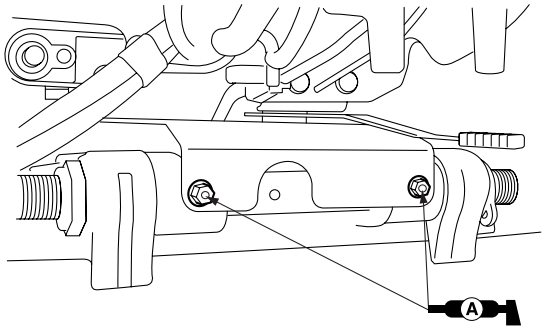
Checking the gear oil level

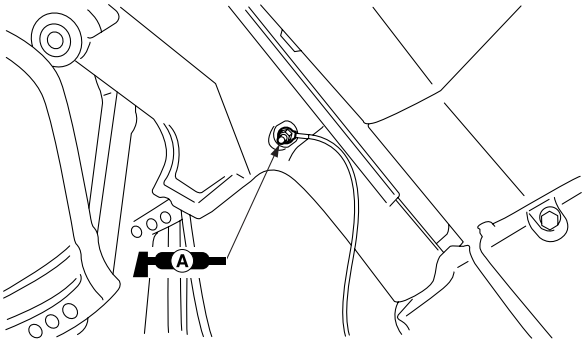
1. Check the gear oil level. See “Checking the gear oil level” (10-5).

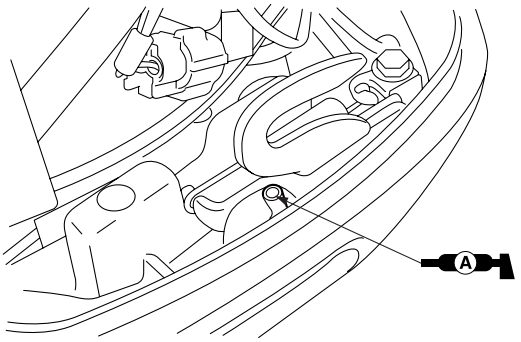
Lubricating the outboard motor

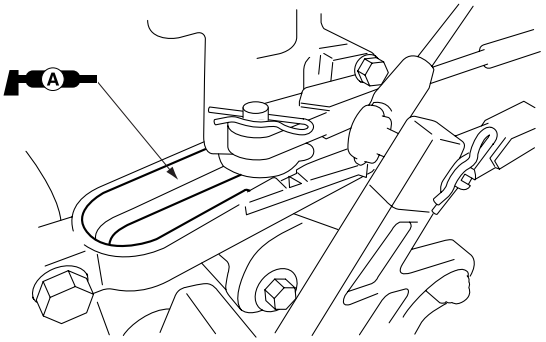
1. Apply water resistant grease to the specified areas.



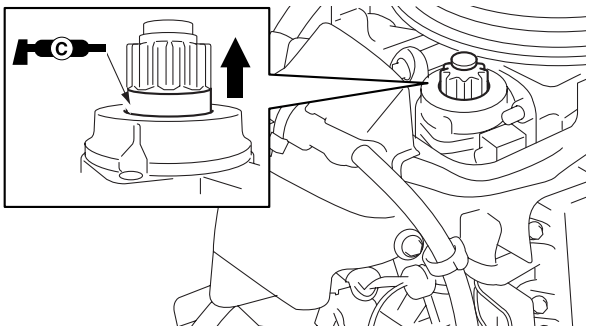




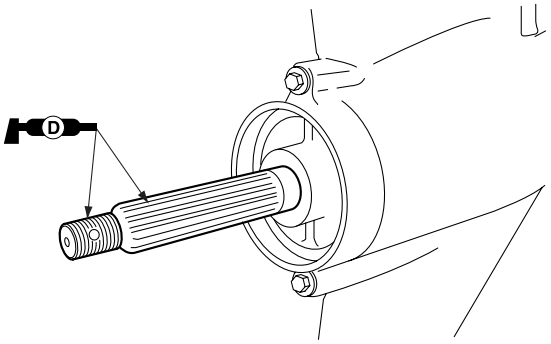




2. Apply low temperature resistant grease to the specified area.



3. Apply corrosion resistant grease to the specified area.



Checking the propeller

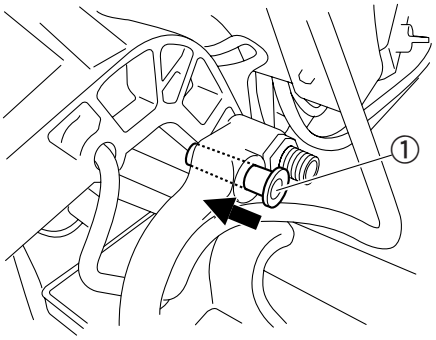
1. Check the propeller. See “Checking the propeller” (8-3).

Checking the PTT fluid level

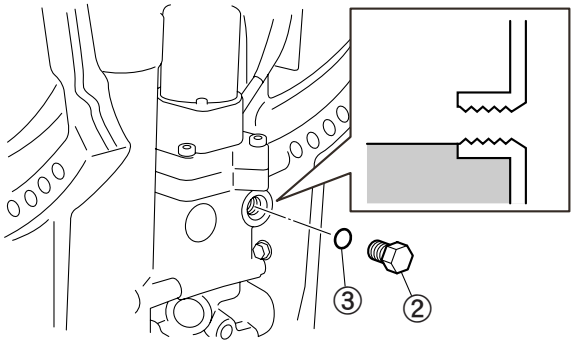
⚠ WARNING

Never get under the outboard motor while it is tilted.

1. Tilt the outboard motor to the fully up position, and then support it with the tilt stop lever ①.



2. Remove the reservoir cap ② and the O-ring ③, and then check the fluid level in the reservoir. **WARNING! Make sure that the tilt ram is fully extended when removing the reservoir cap.**



TIP:

If the fluid is at the correct level, a small amount of fluid should overflow out of the filler hole when the reservoir cap is removed.

3. If the fluid is below the correct level, add the recommended fluid to bring it up to the correct level.

Recommended PTT fluid: ATF Dexron II

4. Install a new O-ring ③ and the reservoir cap ②, and then tighten the reservoir cap ② to the specified torque.

Reservoir cap ②:
7 N·m (0.7 kgf·m, 5.2 ft·lb)

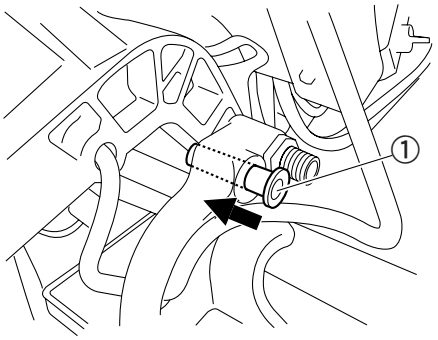
Checking the PTT operation

1. Tilt the outboard motor to the fully up and down positions a few times and check the entire tilt range for smooth operation. Check the PTT fluid level if the tilt operation is not smooth.

TIP:

Make sure that the PTT motor makes a winding sound when it is operating smoothly.

2. Tilt the outboard motor to the fully up position, and then support it with the tilt stop lever ① to check that the lock mechanism of the tilt stop lever works properly.



3. Check the PTT unit for fluid leakage.

Adjusting the shift cable

1. Remove the shift cable, and then adjust it. See “Installing the shift cable and throttle cable (remote control model)” (3-14).

Checking the spark plug

1. Check the spark plugs. See “Checking the spark plug” (7-42).

Checking the timing belt

1. Check the timing belt. See “Checking the timing belt and sprocket” (7-15).

Replacing the timing belt

1. Replace the timing belt. See “Flywheel magnet and timing belt” (7-12).

Checking the thermostat

1. Check the thermostat. See “Checking the thermostat” (7-49).

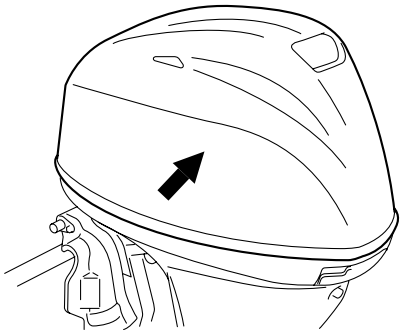
Adjusting the throttle link rod and throttle cable

1. Adjust the throttle link rod. See “Adjusting the throttle link rod” (6-23).

2. Install the throttle cable. See “Installing the shift cable and throttle cable (remote control model)” (3-14).

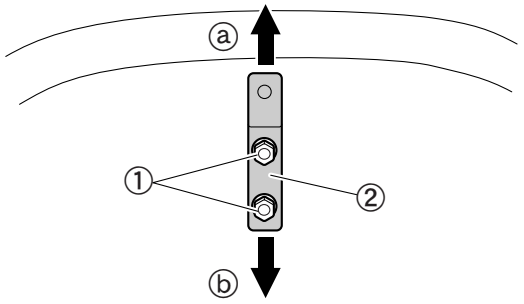
Checking the top cowling

1. Check the fitting by pushing the top cowling with both hands. Adjust if there is free play.



2. Loosen the nuts ①.

3. Move the hook ② up or down slightly to adjust its position.



TIP:

- To loosen the fitting, move the hook in direction ⓐ.
- To tighten the fitting, move the hook in direction ⓑ.

4. Tighten the nuts ①.

5. Check the fitting again. Replace the cowling seal if the free play cannot be adjusted.

Checking the valve clearance

1. Check the valve clearance. See “Checking the valve clearance” (7-2).

Checking the water pump

1. Check the water pump housing and impeller. See “Checking the water pump” (8-5).

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— MEMO —

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— MEMO —

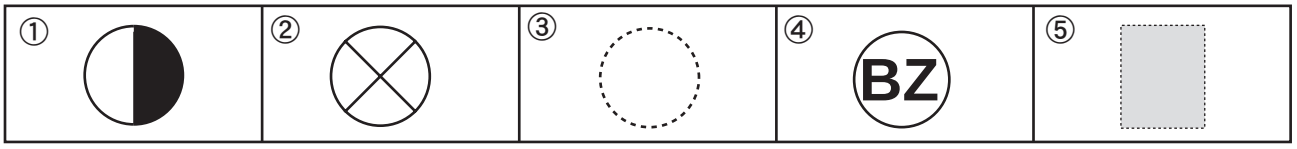
Wiring diagram

How to use the wiring diagram

Composition of the wiring diagrams

The wiring diagram consists of three categories. The fuel unit and ignition unit, the charging unit and starting unit, and the control unit.

Legend symbols in the wiring diagrams



① Double colors wire
② No wire connector
③ A wire is not included in the selected wiring unit.
④ Alert buzzer
⑤ Option parts

Color Code

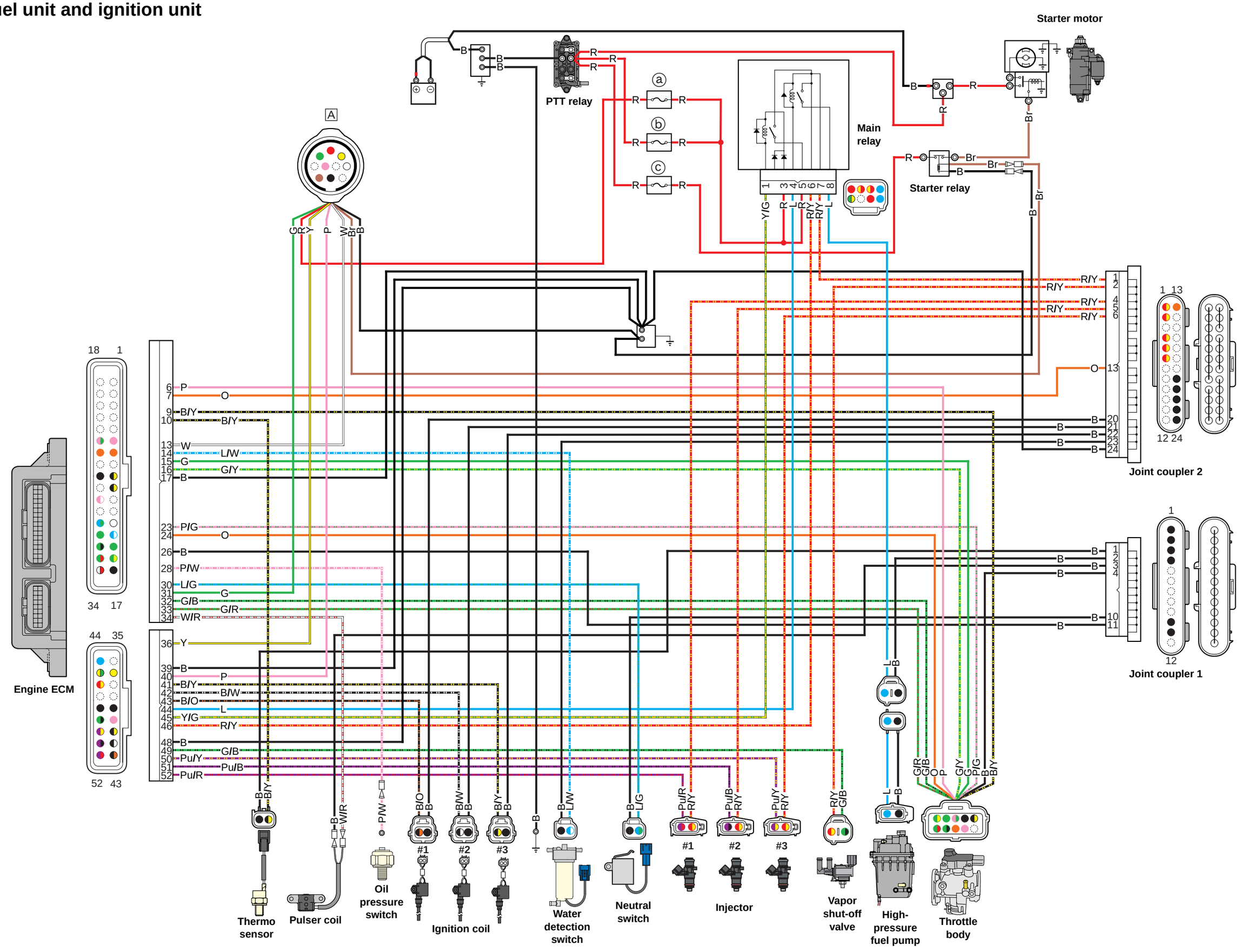
B : Black
Br : Brown
G : Green
L : Blue
Lg : Light green
O : Orange
P : Pink
R : Red
Sb : Sky blue
W : White
Y : Yellow
B/O : Black/Orange
B/W : Black/White
B/Y : Black/Yellow
Gy : Gray
G/B : Green/Black
G/R : Green/Red
G/Y : Green/Yellow
L/B : Blue/Black
L/G : Blue/Green
L/R : Blue/Red
L/W : Blue/White
O/W : Orange/White
P/B : Pink/Black
P/G : Pink/Green
P/W : Pink/White
Pu/B : Purple/Black
Pu/R : Purple/Red
Pu/Y : Purple/Yellow
R/B : Red/Black
R/G : Red/Green
R/Y : Red/Yellow
W/B : White/Black
W/G : White/Green
W/R : White/Red
W/L : White/Blue
Y/G : Yellow/Green

Fuel unit and ignition unit

ⓐ Fuse (20A) (engine start switch, PTT switch)
ⓑ Fuse (30A) (main relay)
ⓒ Fuse (20A) (starter relay)

🄰 To tiller handle/remote control

Fuel unit and ignition unit

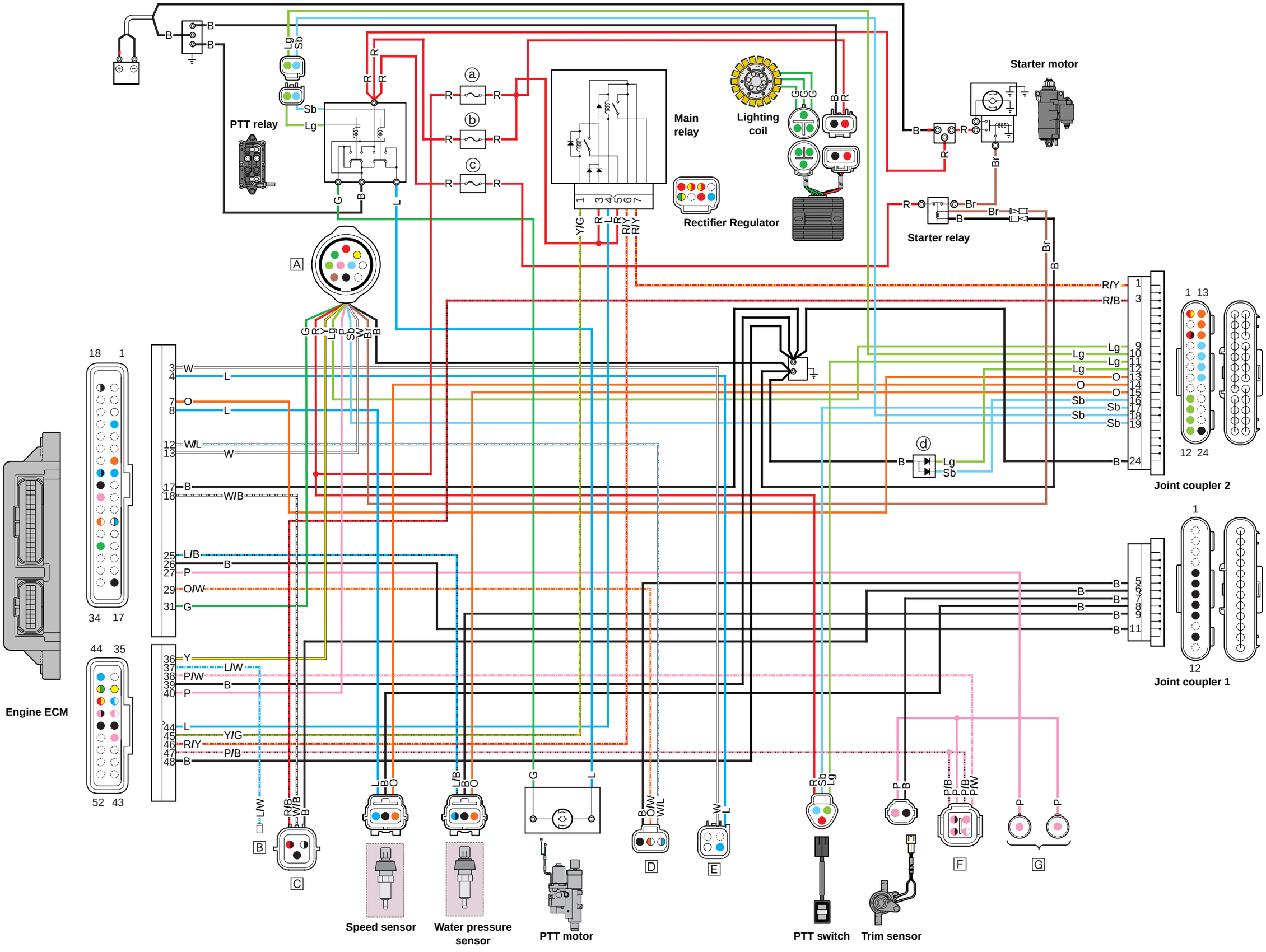


Charging unit and starting unit

ⓐ Fuse (20A) (engine start switch, PTT switch)
ⓑ Fuse (30A) (main relay)
ⓒ Fuse (20A) (starter relay)
ⓓ Diode (connect to PTT relay)

Ⓐ To tiller handle/remote control
Ⓑ To diagnostic flash indicator
Ⓒ To YDIS
Ⓓ To trolling switch
Ⓔ To 6Y8 Multifunction Meter
Ⓕ To alert indicator (tiller handle/digital tachometer)
Ⓖ Connect the couplers when displaying the 6Y8 Multifunction Meter

Charging unit and starting unit



Control unit

A Tiller handle
B 704 remote control
C 703 remote control
D To power unit
E To gauge